Forest Vegetation of the Routt National Forest in Northwestern Colorado: A Habitat Type Classification

George R. Hoffman and Robert R. Alexander

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Abstract

A vegetation classification based on concepts and methods developed by Daubenmire were used to identify 11 forest habitat types in the Routt National Forest. Included were five habitat types in the *Populus tremuloides* series, two in the *Abies lasiocarpa* series, and one each in *Pinus contorta*, *Pseudotsuga menziesii*, *Pinus flexilis*, and *Quercus gambelii* series. A key to identify the habitat types and the management implications associated with each are provided.

Foreword

In 1976, George R. Hoffman began a detailed study of the forest vegetation on the Routt National Forest under a cooperative agreement with the USDA Forest Service, Rocky Mountain Region, and the Rocky Mountain Forest and Range Experiment Station. The results reported here are intended for two primary audiences: forest managers and land use planners who want a working tool to use on the Routt National Forest, and ecologists who want a research tool to use in related studies. Not all readers will find each category of information of equal value.

Robert R. Alexander

Cover photo.—*Populus tremuloides/Thalictrum fendleri* habitat type on the Routt National Forest with several size classes of *P. tremuloides* represented.

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Forest vegetation on the Routt National Forest and adjacent areas has been studied previously to a limited extent, but this study comprehensively categorizes and describes forest habitat types based on quantitative data. Many of the earlier studies of forest vegetation were management oriented or autecologic in scope, but a few are relevant to the present study. Bunin (1975) described vegetation below the subalpine zone, on the west side of the Park Range. Although the sampling methods and nomenclature differ from the study reported here, it is evident that four of the habitat types described in this paper were observed. Adjacent to the Routt to the north, Wirsing and Alexander (1975) described five habitat types on the Medicine Bow National Forest. Two of these also occur on the Routt. On the Crested Butte area south of the Routt, Langenheim (1962) described several mature biotic communities which appear from general descriptions to be similar to three of the habitat types on the Routt.

This cooperative study was started in 1976 to (1) identify and describe forest habitat types in the Routt National Forest; (2) relate habitat types to topographic, edaphic, and climatic factors; (3) describe successional patterns of forest vegetation; and (4) relate Routt habitat types to other Rocky Mountain forests with similar classifications. The habitat type classification[2] completed in 1978 is based on concepts and methods developed by Daubenmire and Daubenmire (1968), Hoffman and Alexander (1976), Reed (1976), and Pfister et al. (1977).

STUDY AREA

Physiography and Geology

The Routt National Forest, in northwestern Colorado (fig. 1), lies within the Southern Rocky Mountain and Wyoming Basin physiographic provinces described by Fenneman (1931). The Colorado Plateau lies immediately to the southwest. The main physiographic features of the region are the north-south trending Park Range-Gore Range mountains and the east-west trending Elkhead Mountains to the west of the Park Range. In the southwestern extreme of the Routt National Forest, flat-topped and steep-sided topography of the White River Plateau is conspicuous. The northeastern segment of the Forest is east of North Park along the western flank of the Medicine Bow Mountains. East of the Park Range-Gore Range is an elliptic-shaped basin of Cretaceous and Tertiary deposits. The basin is mostly unforested and constitutes North Park, and Middle Park which is south of the study area. The Rabbit Ears Range is an east-west oriented anticline that separates North and Middle Parks. Smaller parks are common throughout the Routt National Forest, especially in the area north and west of Hahn's Peak, where much of the surficial deposit is sedimentary of Cretaceous or Tertiary age.

Climate

Precipitation in the Routt National Forest increases with elevation. Mean annual precipitation varies from about 20 inches (52 cm) at 8,600 feet (2,620 m), in the *Populus tremuloides* forest zone, to about 40 inches (102 cm) at 10,000 feet (3,050 m), in the *Abies lasiocarpa* forest zone. At these elevations, somewhat more than one-half the total precipitation falls as snow during the six coldest months of the year.

Mean annual temperature in the *Populus tremuloides* forest zone is about 41° F (5° C), with a January mean of 21° F (−6° C), and a July mean of 59° F (15° C). In the *Abies lasiocarpa* forest zone, mean annual temperature is about 34° F (1° C), with a January mean of 14° F (−10° C) and a July mean of 54° F (12° C).

The limited temperature and precipitation data from published records are useful in characterizing the Routt National Forest in broad general terms. However, mountainous topography produces so much variation in temperature and precipitation that it is difficult to provide any meaningful climatic information for a given locality.

[2]*Hoffman, George R. Forest vegetation on the Routt National Forest, Colorado: A habitat type classification. 135 p. Unpublished report on file at the Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colo. (FS-RM-MFRWU-1252).*

Figure 1.—Routt National Forest, Colorado study area. Intensively sampled sites are indicated by dots.

METHODS

Field Sampling

Preliminary work began in 1976 with a reconnaissance survey of more than 200 sites through the Routt National Forest. Plant species were collected, and a list of possible habitat types and study sites were noted with brief descriptions.

During the summers of 1977 and 1978, 97 stands were intensively sampled. These stands were mostly old-growth and climax or in late seral stages of succession. They were representative of the forest communities characterized by the following tree species: *Quercus gambelii*, *Pinus flexilis*, *Pseudotsuga menziesii*, *Populus tremuloides*, *Pinus contorta*, *Abies lasiocarpa*, and *Picea engelmannii*.

In each stand, a 49.2- by 82.0-foot (15- by 25-m) plot was laid out with the long dimension parallel to the contour and was located in the stand to avoid ecotones and disturbances. Each main plot was then subdivided into three

16.4- by 82.0-foot (5- by 25-m) subplots. Within each 4,036-square-foot (375-m^2) main plot, all trees taller than 3.28 feet (1 m) were measured at breast height and recorded by 0.328-foot (1-dm) classes. Trees less than 3.28 feet (1 m) tall were counted in two 3.28- by 82.0-foot (1- by 25-m) transects along the inner sides of the central subplot.

Canopy cover of the understory shrubs, forbs, and graminoids was estimated in fifty 7.87- by 19.68-inch (2- by 5-dm) microplots, placed systematically along the inner sides of the central subplot. Canopy coverage of each species was recorded as one of six coverage classes (1-5%, 6-25%, 26-50%, 51-75%, 76-95%, and 96-100%). Also listed were those species not occurring in the 50 microplots, but present within the 4,036-square-foot (375-m^2) main plot.

Finally, 25 cores representing the upper decimeter of the mineral soil were collected from each stand. These samples were air dried in the field, then composited for laboratory analysis.

ANALYSIS OF DATA

Tree-size class data were combined according to habitat type, and mean values for each size class in each habitat type were recorded (table A-1).

For each microplot examined, the midpoints of the coverage classes were used to calculate average percent coverage for each shrub, graminoid, and forb species. Frequency was also determined for each species. Coverage and frequency data for all understory species plus site data are shown in appendix tables A-2 through A-11. Species coverage and selected stand characteristics were then transferred to an association table. Stands were arranged and rearranged to group stands with similar floristic composition and climax tree species. Habitat type separation was based on a consideration of both overstory and major shrubs, graminoids, and forbs (Daubenmire 1952, Daubenmire and Daubenmire 1968, Mueller-Dombois and Ellensburg 1974).

Soil texture was determined by a modified Bouyoucos method (Moodie and Koehler 1975). Other soil characteristics determined were pH (using a glass electrode on the saturated soil paste), cation exchange capacity, and exchangeable Ca, Mg, and K on the ammonium acetate extract. N by the Kjeldahl method, OM by a modified Walkley-Black method, and P by the Bray technique were also determined for each sample (Moodie and Koehler 1975).

Nomenclature for plants collected in this study follows Harrington (1954) and Weber (1976). Although plants were collected at various times during the growing season, some taxonomic difficulties persisted. Most of these resulted from hybridization among two or more species which have not been studied systematically to clarify the taxonomy. Other taxonomic difficulties related to lack of flowering specimens. Where considerable variation made it impossible to determine species, genera only were used.

ECOLOGIC TERMS AND CONCEPTS

Because terminology in ecology is not uniformly used or understood, the terms and concepts used in this paper are defined below. Unless stated otherwise, all terms follow usage proposed by Daubenmire and Daubenmire (1968).

"Climax vegetation" is that which has attained a steady state with its environment; species of climax vegetation successfully maintain their population sizes. "Seral communities" are stands of vegetation that have not attained a steady state; current populations of some species are being replaced by other species. All stands of climax vegetation that have the same overstory and understody dominants are grouped into a single "plant association." Plant associations having the same overstory (climax) dominants are grouped into "series" (Hoffman and Alexander 1976).

The Routt National Forest has been disturbed by fire, logging, and grazing for many years. Because of these disturbances, not all of the land area currently supports climax vegetation. However, that land area which either supports, or has the potential of supporting, a single plant association is called a "habitat type." It is possible that much of the area of a habitat type will never attain climax status. Nevertheless, it is important to consider land units in terms of their potential status. The practical value of habitat type classifications is only beginning to be realized in areas of tree productivity, disease and insect susceptibility, potential for producing browse, soil moisture depth, and tree regeneration (Arno and Pfister 1977; Daubenmire 1961, 1973; Layser 1974; Pfister 1972). The habitat type concept offers a useful approach to managing forest resources.

Habitat type is the basic unit in classifying lands or sites based on potential (climax) natural vegetation. Series is the next higher category of classification (Hoffman and Alexander 1976). For example, all habitat types with *Quercus gambelii* the potential climax dominant are grouped into the *Quercus gambelii* series. The series is more than an artificial grouping of habitat types using the potential climax dominant as the convenient thread of continuity. There is an ecologic basis for grouping habitat types into series. For example, *Quercus gambelii* occupies areas that are warmer and drier than areas where *Pseudotsuga menziesii* is climax. Continuing higher into the mountains, *Populus tremuloides*, *Pinus contorta*, *Picea engelmannii*, and *Abies lasiocarpa* successively become the dominant species. In the absence of adequate data for the Routt National Forest, it is assumed that these self-perpetuating populations of dominant trees are related to the macroclimate, whereas the understory vegetation is related more to microclimate and soils. Stands in a series have the same general appearance whether they are in the Routt National Forest or in nearby forests of Colorado and Wyoming. Habitat types within a series are differentiated on the basis of understory vegetation.

Table 1.—Selected topographic and edaphic characteristics of the habitat types in the Routt National Forest

Habitat type	Number of stands sampled	Elevation	Soil texture[1]	pH[1]	Organic matter[1]
		m			%
Pinus flexilis/Juniperus communis	3	2,530-2,615	sand	3.6-6.5	0.9-2.2
Quercus gambelii/Symphoricarpos oreophilus	3	2,240-2,256	loam-loamy sand	6.3	3.5-4.5
Pseudotsuga menziesii/Pachistima myrsinites	2	2,164-2,573	sandy loam	5.9-6.2	3.7
Populus tremuloides/Symphoricarpos oreophilus	7	2,256-2,560	loam-sandy loam	5.9-6.7	4.7-6.4
Populus tremuloides/Thalictrum fendleri	26	2,475-2,957	loamy sand-silt loam	5.2-6.2	3.0-9.5
Populus tremuloides/Heracleum sphondyllium	4	2,444-2,688	sandy loam-clay loam	5.6-6.2	3.9-9.5
Populus tremuloides/Veratrum tenuipetalum	3	2,682	sandy loam-	5.6-6.1	5.5-7.4
Populus tremuloides/Pteridium aquilinum	7	2,475-2,755	loam-sandy loam	5.1-5.9	3.2-6.6
Pinus contorta/Shepherdia canadensis	6	2,755-2,950	sandy loam	5.0-5.3	1.6-3.5
Abies lasiocarpa/Vaccinium scoparium	25	2,365-3,078	sandy loam-silt loam	4.3-5.5	1.9-6.6
Abies lasiocarpa/Carex geyeri	11	2,111-2,952	loam-sandy loam	4.6-6.0	1.8-5.3

[1]*Upper 1 dm of soil*

HABITAT TYPES

Pinus flexilis Series

Pinus flexilis is not an economically important species on the Routt National Forest. It occurs as the sole dominant in isolated, low-density stands at elevations ranging from 8,300 feet (2,530 m) to about 8,580 feet (2,615 m) (table 1).

This series is represented by three plots and one habitat type. All plots were in the northwestern part of the Routt National Forest, on southwest to northwest slopes. Basal areas on the study plots ranged from 54 to 118 square feet per acre (12 to 27 m^2/ha). Tree sizes generally ranged from seedlings to 24- to 28-inch (6- to 7-dm) d.b.h. class. Tree population and undergrowth data for *Pinus flexilis* stands are shown in appendix tables A-1 and A-2.

Pinus flexilis/Juniperus communis

Description.—The understory of this habitat type is characterized by the dominance of *Juniperus communis* and the relative scarcity of other species (fig. 2). *Leucopoa kingii* was the only graminoid in all stands sampled. Most of the understory species also were in adjacent plant communities dominated by *Artemisia tridentata*. Soils in this habitat types are shallow, and the parent material is commonly exposed at the ground surface (fig. 3).

Wirsing and Alexander (1975) reported a *Pinus flexilis/Hesperochloa kingii (Leucopoa kingii)* habitat type north of the Routt National Forest in the Medicine Bow National Forest. Their stands were all at high elevation in the *Abies lasiocarpa* zone, though some floristic similarities are evident. In north-central Wyoming, Hoffman and Alexander (1976) reported *P. flexilis* was a seral species in the *Pseudotsuga menziesii* zone of the Bighorn Mountains where it was observed apparently moving into the surrounding shrub-steppe. Farther north, in Montana, Pfister et al. (1977) reported *P. flexilis/J. communis* habitat type east of the Continental Divide at elevations of 4,600 to 8,300 feet (1,405 to 2,530 m). *P. flexilis/J. communis* stands of the present study show little floristic similarity to those in Montana. *P. flexilis* also grows at low elevations at the southern end of the Wind River and Absaroka Mountains (Steele et al. 1979).

Management implications.—This dry habitat type has very low productivity for timber production. Forage value for livestock and big game is low to moderate, with some evidence of use by deer in the spring and fall. Overstory trees adjacent to grasslands may provide cover for wildlife. *P. flexilis* seeds are large and are food for birds and small mammals.

Figure 2.—*Pinus flexilis/Juniperus communis* habitat type. Trees are short and widely spaced. Note: the meter stick in this and subsequent photographs is marked in decimeters.

Figure 3.—Exposed, rocky parent material under a stand of *Pinus flexilis/Juniperus communis* habitat type.

Pseudotsuga menziesii Series

Pseudotsuga menziesii and *Pinus ponderosa* are not widespread or abundant in the Routt National Forest. Bates (1924) suggested that this may be due to repeated fires that converted lands formerly occupied by these species to forests dominated by *Populus tremuloides* and *Quercus gambelii* (table 1).

The *Pseudotsuga menziesii* series was sampled in only two plots and one habitat type that were on steep northwest slopes at elevations of 7,080 to 8,465 feet (2,160 to 2,580 m). *P. menziesii* is climax in some areas and seral to *Abies lasiocarpa* in others. *Populus tremuloides* may be present as a seral species. Basal areas on the study plots range from 113 to 218 square feet per acre (20 to 50 m^2/ha). Tree sizes range from seedlings to the 12- to 16-inch (3- to 4-dm) d.b.h. class. Tree population and undergrowth data for *Pseudotsuga menziesii* stands are shown in appendix tables A-1 and A-3.

Pseudotsuga menziesii/Pachistima myrsinites

Description.—The *Pseudotsuga menziesii/Pachistima myrsinites* habitat type is recognized by the presence and reproductive success of *Pseudotsuga menziesii* and by the abundance and dominance of *Pachistima myrsinites* in the undergrowth (fig. 4). Other important shrub species are *Acer glabrum*, *Amelanchier alnifolia*, *Symphoricarpos oreophilus*, *Vaccinium myrtillus*, and *Quercus gambelii*. The most conspicuous herbaceous plants are *Arnica cordifolia*, *Aster engelmannii*, *Epilobium angustifolium*, *Lathyrus leucanthus*, and *Osmorhiza* sp. No *Pseudotsuga*-dominated habitat types were reported in the Medicine Bow National Forest (Wirsing and Alexander 1975). In the Wind River Mountains, Reed (1976) described a *P. menziesii/Symphoricarpos oreophilus* habitat type, and Steele et al. (1979) described a *P. menziesii/Acer glabrum* habitat type which is somewhat similar to the *Pseudotsuga menziesii/Pachistima myrsinites* habitat type on the Routt. In the Bighorn Mountains, *Pseudotsuga* is widespread and dominates the *P. menziesii/Berberis repens* and *P. menziesii/Physocarpus monogynous* habitat types (Hoffman and Alexander 1976).

Management implications.—Little information is available on the management of this limited habitat type. Timber productivity is below the average for *Pseudotsuga*, because it grows in relatively dry situations. Regeneration is likely to be difficult to obtain if stands are clearcut. Group selection and shelterwood cuttings approximate the regeneration patterns observed in natural forests. Livestock forage production is low, and the potential for increasing it is not very great. Big game may browse the shrub species heavily at times. Shrub species can be increased by maintaining low overstory basal areas. The potential for increasing natural runoff is not very great because of the limited area occupied by the habitat type.

Figure 4.—*Pseudotsuga menziesii/Pachistima myrsinites* habitat type on a steep slope. *Populus tremuloides* is the codominant tree in this stand.

Quercus gambelii Series

Quercus gambelii occupies a zone between the *Artemisia tridentata*-dominated shrub-steppe and the wetter forest habitats upslope (table 1). In some locations, *Q. gambelii* is adjacent to or intermingled with *Populus tremuloides*-dominated forests. *Q. gambelii* frequently forms dense, nearly impenetrable thickets with associated shrubs. In other locations, small-statured forests with a recognizable undergrowth develop.

This series is represented by three plots, located on southeast to northwest slopes at 7,350 to 7,400 feet (2,240 to 2,256 m) elevation. Only one habitat type has been recognized in this series. Basal areas on the study plots ranged from 44 to 157 square feet per acre (10 to 36 m^2/ha). Tree sizes varied from seedlings to mostly the 4- to 8-inch (1- to 2-dm) d.b.h. class, with an occasional larger stem. Tree population and undergrowth data for *Quercus gambelii* stands are recorded in appendix tables A-1 and A-4.

Quercus gambelii/Symphoricarpos oreophilus

Description.—The understory of this habitat type characteristically has both woody and herbaceous species, but is dominated by *Symphoricarpos oreophilus* (fig. 5). *Amelanchier alnifolia* and *Prunus virginiana melanocarpa* were shrubs present in all stands sampled. *Artemisia tridentata* was present in two stands. Among the constant herbaceous species present were *Poa interior*, *Achillea millefolium*, *Erigeron elatior*, and *Vicia americana*. *Agropyron trachycaulum*, *Bromus ciliatus*, *Carex geyeri*, *Poa pratensis*, *Stellaria jamesiana*, *Thlaspi montanum*, and *Wyethia amplexicaulis* were all present in two stands. A number of the undergrowth species in this habitat type were present under *Q. gambelii* in west-central Colorado (Brown 1958). Wirsing and Alexander (1975) did not identify a *Q. gambelii* habitat type on the Medicine Bow National Forest in southern Wyoming, but did recognize a xerophytic *Q. gambelii* community in the dry foothills and canyons.

Management implications.—Little is known about this dry habitat type. It has little value for timber or water production. Value for livestock varies with the amount of graminoids in the understory. It provides spring and fall habitat for big game and food and cover for nongame animals.

Populus tremuloides Series

Populus tremuloides is the most abundant tree species in the Routt National Forest. It occurs from low elevation, often adjacent to or intermingled with *Quercus gambelii*, to near timberline (table 1). It is most vigorous at intermediate elevations where temperature and moisture regimes are moderate.

Figure 5.—*Quercus gambelii/Symphoricarpos oreophilus* habitat type. Most *Quercus* stands occur as dense thickets outside the national forest boundary.

There has been considerable discussion regarding the role of *P. tremuloides* as a climax and/or seral species in the Rockies; both assessments may be correct. In some areas, *P. tremuloides* dominates sites where fires have destroyed coniferous forests. In time, conifers gradually replace *P. tremuloides* (fig. 6). Succession to coniferous forest is apparently slowed significantly by changes in soil resulting from site occupancy by the deciduous *Populus*. In other areas, *P. tremuloides* forests appear to be climax without evidence of conifer invasion. According to Mueggler (1976), complete conversion of *Populus* stands to coniferous climax forest may require more than 1,000 fire-free years. The origin of both seral and climax *P. tremuloides*-dominated forests may be the same—destruction of coniferous forest by repeated fires.

Many *P. tremuloides* forests are even-aged; the trees originate from sprouts after a disturbance. Baker (1925) suggested that in stands where older trees die naturally over a short time span, an even-aged replacement stand may develop. Other stands are uneven-aged, and sprouts apparently provide sufficient numbers of young trees to perpetuate the species indefinitely. Two-storied stands are also relatively common and can develop when surface fires burn quickly through mature stands, thereby stimulating sprouting.

This series is represented by 47 plots, located on all aspects at elevations of 7,380 to 9,710 feet (2,250 to 2,960 m). Five habitat types were recognized. Basal areas on the study plots range from 35 to 314 square feet per acre (8 to 77 m^2/ha). Tree sizes usually ranged from seedlings to the 12- to 16-inch (3- to 4-dm) d.b.h. class. Occasionally there were scattered trees in the 20- to 24-inch (5- to 6-dm) d.b.h. class. Not all d.b.h. classes were represented on each plot (fig. 7). Stand ages ranged from 45 to 160 years, with a median age of about 80 years on most plots. Tree population and undergrowth data for *Populus tremuloides* stands are shown in appendix tables A-1, A-4, A-5, and A-6.

Populus tremuloides/Symphoricarpos oreophilus

Description.—The *Populus tremuloides/Symphoricarpos oreophilus* habitat type, represented by seven stands, is recognized by the consistent presence and reproductive success of *P. tremuloides* and the abundance and dominance of *S. oreophilus* in the undergrowth (fig. 8). In four of the stands sampled, *P. tremuloides* was the sole dominant tree species; in three others, *Q. gambelii* was a codominant. This habitat type occupies the driest habitats in the *P. tremuloides* zone. All stands sampled were at the lower edge of this zone. In the direction of drier habitats, *P. tremuloides* is replaced by *Quercus gambelii* to form the *Q. gambellii/S. oreophilus* habitat type.

In addition to *S. oreophilus*, important shrubs are *Amelanchier alnifolia*, *Prunus virginiana melanocarpa*, *Rosa woodsii*, and *Mahonia repens*. The most important species in the rich mixture of graminoids and forbs are *Bromus ciliatus*, *Carex geyeri*, *Elymus glaucus*, *Melica spectabilis*, *Poa interior*, *P. pratensis*, *Achillea millefolium*, *Agastache urticifolia*, *Galium boreale*, *Geranium* sp.,

Figure 6.—*Abies lasiocarpa* successfully reproducing and invading a *Populus tremuloides*-dominated forest.

Figure 7.—*Populus tremuloides*-dominated habitat type with only the 1- to 2-dm-diameter and 3- to 4-dm-diameter classes represented.

Figure 8.—*Populus tremuloides/Symphoricarpos oreophilus* habitat type. *Populus* is the only tree in this stand. *Symphoricarpos* provides 40% coverage in the undergrowth.

Lathyrus leucanthus, *Osmorhiza* sp., *Stellaria jamesiana*, *Thalictrum fendleri*, *Valeriana occidentalis*, and *Vicia americana*.

Bunin (1975) recognized a *Symphoricarpos oreophilus*-dominated undergrowth on the west slope of the Park Range in the Routt. In the Medicine Bow National Forest and in the Bighorn Mountains, there are no understory vegetation associations dominated by *Symphoricarpos* (Wirsing and Alexander 1975, Hoffman and Alexander 1976). In the Wind River Mountains, Reed (1976), and in Utah, Henderson et al. (1977), reported *Populus tremuloides/S. oreophilus* habitat types with similar associated undergrowth. In western Wyoming, Youngblood (1979), described this vegetation association as a community type.

Management implications.—Timber productivity is low to moderate in this dry habitat type. Clearcutting and regenerating a new stand is usually the preferred way to handle these stands. Annual precipitation varies from 18 to 24 inches (46 to 61 cm), with about 9 to 12 inches (23 to 30 cm) of runoff. Potential for increasing streamflow under management is unknown. This habitat type is spring and fall big game range, and use may be heavy. In years of low snowfall, it may be used all winter. The habitat type is summer range for livestock. Under proper grazing management, herbage production may be as high as 500 to 800 pounds per acre (560 to 896 kg/ha), with high protein browse important. This habitat type has fairly good scenic quality, but generally with less favorable color contrast than with mixed *Populus*-conifer stands. Mature and open stands generally are more visually attractive, with the shrub understory providing both texture diversity and variety in seasonal color.

Populus tremuloides/Thalictrum fendleri

Description.—This habitat type, represented by 26 stands, is the most widespread of the *Populus*-dominated habitat types in the Routt National Forest (fig. 9). It is recognized by the consistent reproductive success of *Populus tremuloides* and high coverage of *Thalictrum fendleri* in the undergrowth. In 17 of the stands sampled, *P. tremuloides* was the only tree species. In most of the other stands, there was a scattering of seedlings of *Abies lasiocarpa*, *Picea engelmannii*, and *Pinus contorta*, but no clear evidence that these stands were moving toward a climax dominated by conifers. Only one *Populus* stand resembled a seral community. Most of the stands in this habitat type appear to develop into uneven-aged or broad-aged stands that are self-perpetuating.

The undergrowth is primarily a rich mixture of herbaceous species in three distinct strata (fig. 10). Important species in the lowest stratum are: *Carex geyeri*, *Achillea millefolium*, *Androsace septentrionalis*, *Galium boreale*, *Nemophila breviflora*, *Stellaria jamesiana*, *Taraxacum* sp., and *Viola nuttallii*. The intermediate stratum of species, about 16 to 24 inches (4 to 6 dm) high, includes *Melica spectabilis*, *Poa interior*, *Erigeron elatior*, *Geranium richardsonii*, *Lathyrus leucanthus*, *Lupinus argenteus rubricaulis*, *Thalictrum fendleri*, and *Vicia americana*. The tallest stratum, commonly 24 to 36 inches (6 to 9 dm) tall, includes *Bromus ciliatus*, *Elymus glaucus*, *Aster engelmannii*, *Delphinium barbeyi*, *Ligusticum porteri*, and *Osmorhiza* sp.

Bunin (1975) also recognized the *Populus tremuloides/Thalictrum feldleri* habitat type on the west side of the Park Range. Langenheim (1962) described *Populus*-dominated forests in the Crested Butte area that appear similar to the *P. tremuloides/T. fendleri* habitat type. The *Populus tremuloides/Carex geyeri* habitat type of the Medicine Bow National Forest, described by Wirsing and Alexander (1975), shows some similarities to the *P. tremuloides/T. fendleri* habitat type. Youngblood (1979) described a *P. tremuloides/T. fendleri* habitat type in western Wyoming, but in the Wind River Mountains and Bighorn Mountains, no plant associations similar to this habitat type were found (Hoffman and Alexander 1976, Reed 1971).

Management implications.—The *P. tremuloides/T. fendleri* habitat type is the most productive for timber in the *Populus* series. Site quality ranges from average to high. Clearcutting in patches or small blocks and regenerating new stands is the most effective way to handle these stands. This habitat type is the best summer range for big game and for sheep. Forage production under proper grazing management can be as high as 3,000 pounds per acre (3,360 kg/ha). It also provides habitat for numerous nongame animals, but the management implications for them are unknown. This habitat type has the most visually appealing foreground of all *Populus*-dominated habitat types because of the usually wide spacing with large tree diameters and the abundance of wildflowers in the undergrowth. Soils are well developed and erosion is usually not a problem except on deteriorated ranges. In some situations, potential for mass movement appears to be high, especially if the overstory is removed in large clearcut blocks. Annual precipitation is 25 to 40 inches (64 to 102 cm), with about one-half becoming runoff. Potential for increasing streamflow under management is unknown.

Populus tremuloides/Heracleum sphondyllium

Description.—The *Populus tremuloides/Heracleum sphondyllium* habitat type, represented by only four stands all on north and northeast slopes, is more limited than the *P. tremuloides/T. fendleri* habitat type (fig. 11). *P. tremuloides* was the only tree species found in three stands. The remaining stand contained a few small *Abies lasiocarpa*. The understory is dominated by *H. sphondyllium* and species common to the undergrowth of the *P. tremuloides/T. fendleri* habitat type. *H. sphondyllium*, however, usually overtopped all other species. It produced most of the coverage where grazing by livestock was excluded from the stands. The most abundant of other undergrowth species are *Thalictrum fendleri*, *Bromus ciliatus*, *Elymus glaucus*, *Poa palustris*, *Delphinium barbeyi*, *Geranium richardsonii*, *Ligusticum porteri*, and *Mertensia ciliata*.

Figure 9.—*Populus tremuloides/Thalictrum fendleri* habitat type. In this stand, *Populus* occur in all diameter classes up to 5 to 6 dm.

Figure 10.—Undergrowth in the *Populus tremuloides/Thalictrum fendleri* habitat type. Conspicuous plants are *T. fendleri*, in the lower half of the photograph, *Heracleum sphondyllium*, at lower center just to the right of the meter stick, *Geranium richarsonii* in flower, *Elymus glaucus*, and *Bromus ciliatus*.

Figure 11.—*Populus tremuloides/Heracleum sphondyllium* habitat type. This stand has been protected from grazing since 1941.

Bunin (1975) did not recognize a *P. tremuloides/H. sphondyllium*-dominated vegetation, but the best examples of this habitat type in the Routt are not on the west side of the Park Range. Langenheim (1962) reported *Heracleum* sp. in about half the *Populus*-dominated stands observed in the Crested Butte area in Colorado. North of the Routt, *Heracleum* sp. were reported in forests dominated by *P. tremuloides* by Youngblood (1979), but not by Hoffman and Alexander (1976), Reed (1971), or Wirsing and Alexander (1975).

Management implications.—This habitat type is quite similar in management implications to the *P. tremuloides/T. fendleri* habitat type in the Routt National Forest, and the two can be treated in the same manner.

Populus tremuloides/Veratrum tenuipetalum

Description.—This habitat type is restricted to very wet sites (fig. 12). Only three stands were sampled. *P. tremuloides* was the only tree species in one stand and was the dominant self-reproducing tree species in the other stands. The undergrowth is characterized by the abundance of *Veratrum tenuipetalum*. Other important undergrowth species are *Bromus ciliatus*, *Poa palustris*, *Hydrophyllum capitatum*, *Ligusticum porteri*, *Mertensia ciliata*, and *Thalictrum fendleri*.

Weber (1976) and others have suggested that *Veratrum tenuipetalum* is an indicator of site deterioration and forms dense stands on overgrazed subalpine meadows. In the present study, *V. tenuipetalum* grew in wet habitats, not widely distributed within the *Populus tremuloides* zone. The stands studied had not been grazed recently, and whether past grazing history in this habitat type significantly effected the composition of undergrowth is not known.

No similar habitat types have been reported in *Populus*-dominated stands in the Medicine Bow National Forest or Wind River and Bighorn Mountains (Hoffman and Alexander 1976, Reed 1971, Wirsing and Alexander 1975).

Management implications.—This habitat type is restricted in area. The management implications are similar to those of the *P. tremuloides/T. fendleri* habitat type. However, if *Veratrum tenuipetalum* is an indicator of site deterioration resulting from overgrazing, the potential for timber and forage production and infiltration is less than in the *P. tremuloides/T. fendleri* habitat type, and the potential for increased erosion, surface runoff, and mass movement is greater. Consequently, more care must be exercised in locating and building roads and in harvesting timber.

Populus tremuloides/Pteridium aquilinum

Description.—The *Populus tremuloides/Pteridium aquilinum* habitat type is represented by seven stands (fig. 13); all study sites were located in the Park Range and

Figure 12.—*Populus tremuloides/Veratrum tenuipetalum* habitat type *V. tenuipetalum* is the major undergrowth species.

Figure 13.—*Populus tremuloides/Pteridium aquilinum* habitat type. *Populus* is the only tree species and occurs in five diameter classes. *Pteridium aquilinum* provides 74% coverage in the undergrowth.

Elkhead Mountains on northwest, east, and south slopes in topographic positions that seemingly were poorly drained. Young trees of *A. lasiocarpa* were present in three stands, but their successional status is unclear. In addition to *Populus tremuloides* dominance as the most prolific self-reproducing tree species, this habitat type is recognized by the dominance of *Pteridium aquilinum* in the undergrowth. Other important understory species are *Bromus ciliatus*, *Carex geyeri*, *Elymus glaucus*, *Aster engelmannii*, *Delphinium barbeyi*, *Galium borale*, *Geranium richardsonii*, *Lathyrus leucanthus*, *Ligusticum porteri*, *Osmorhiza* sp., *Stellaria jamesiana*, *Thalictrum fendleri*, and *Vicia americana*.

In the Routt National Forest, the *Populus tremuloides/Pteridium aquilinum* habitat type has a rather restricted distribution. It was not observed south of 40°20′ N latitude. Bunin (1975) also observed this habitat type on the west slope of the Park Range. Morgan (1969) reported no *Pteridium aquilinum* in stands of *Populus* forests in Gunnison County, Colorado, even though a stand in which *Pteridium* was very abundant in the undergrowth was photographed. Langenheim (1962) also did not report *P. aquilinum* in *Populus* forests near Crested Butte. Northward in Wyoming, Idaho, and Montana, no *Populus/Pteridium* habitat type has been reported (Hoffman and Alexander 1976; Pfister et al. 1977; Reed 1971; Steele et al. 1975, 1979; Wirsing and Alexander 1975; Youngblood 1979).

Management implications.—The management implications of this habitat type are similar to the *Populus tremuloides/Thalictrum fendleri* habitat type, with the same potential for reduced benefits and increased risks from management activities as noted for the *P. tremuloides/Veratrum tenuipetalum* habitat type, because *Pteridium aquilinum* is also considered to be an indicator of site deterioration.

Pinus contorta Series

Pinus contorta in the Routt National Forest and elsewhere in the Rocky Mountains is usually attributed to widespread and repeated fires. There is less agreement on its successional status. Many ecologists and foresters consider *P. contorta* a seral species, which, in the absence of fire, would be replaced by forests dominated by *Picea engelmannii*, *Abies lasiocarpa*, and *Pseudotsuga menziesii* (Clements 1910, Daubenmire 1943, Mason 1915). More recently, investigators have concluded that *Pinus contorta* is climax or at least a long-lived subclimax species in certain topoedaphic situations. Moir (1969) reported it to be climax within the upper montane zone of the Front Range of Colorado. Hoffman and Alexander (1976) described climax *P. contorta* forests in the Bighorn Mountains, Wyoming, occurring on soils derived from granites, with low nutrient and waterholding capacities. Climax *P. contorta* forests are described in the Wind River and Absaroka Mountains, western Wyoming, by Reed (1976) and Steele et al. (1979). Pfister et al. (1977) reported apparently stable and climax *Pinus contorta* forests in Montana.

In the Routt National Forest, *P. contorta* was not encountered in *Pseudotsuga menziesii* forests and only rarely in *Populus tremuloides* forests; but it was a common seral species in *Picea engelmannii/Abies lasiocarpa* forests. In fact, some of the largest *Pinus contorta* encountered on the Routt National Forest were in *Abies*-dominated habitat types (fig. 14). Seral *P. contorta* is more likely to be even-aged and bear a high proportion of serotinous cones. Where *P. contorta* is the dominant self-reproducing species, it may exhibit a population structure of several age classes, and has no competition from its common associates (table 1). Climax *P. contorta* stands are more likely to contain a higher proportion of trees bearing nonserotinous cones.

In some areas on the Routt National Forest, especially on dry poor sites, *P. contorta* forms dense dog-hair stands with little undergrowth. In these situations, *P. contorta* may be a seral species that will occupy the site for hundreds of years simply because there is no seed source of climax species available for reinvasion.

This series is represented by six stands located at elevations of 9,040 to 9,680 feet (2,755 to 2,950 m) on soils derived from sedimentary rock. Only one *P. contorta*-dominated habitat type has been recognized. Basal areas on the study plots ranged from 118 to 386 square feet per acre (57 to 89 m^2/ha). Tree sizes ranged from seedlings to the 12- to 16-inch (3- to 4-dm) d.b.h. class, with an occasional tree in the 16- to 20-inch (4- to 5-dm) d.b.h. class. Age varied from 100 to 200 years. Tree population and undergrowth data are shown in appendix tables A-1 and A-8.

Pinus contorta/Shepherdia canadensis

Description.—All *P. contorta* stands sampled were in the southern part of the Routt National Forest. Five stands were located on well drained soils derived from sandstone/conglomerate. The remaining stand was on soil derived from Holocene landslide substrate.

The constant presence and reproductive success of *P. contorta*, the absence of any significant reproduction of other tree species, and the understory dominance of *Shepherdia canadensis* are the diagnostic features of this habitat type (fig. 15). Other important shrub species are *Juniperus communis*, *Pachistima myrsinites*, *Rosa* sp., *Vaccinium myrtillus*, and *V. scoparium*. *Arnica cordifolia* is the most common forb in the undergrowth.

Reed (1971) described a *Pinus contorta/Poa nervosa* habitat type in the Wind River Mountains in which *Shepherdia canadensis*, *Juniperus communis*, and *Rosa acicularis* were present in about half the stands. This habitat type had a more luxuriant undergrowth and occurred on more favorable sites than *Pinus contorta/S. canadensis* habitat type in the Routt. In the Wind River and Absaroka Mountains, Steele et al. (1979) described an *Abies lasiocarpa/Arnica cordifolia* habitat type that is similar to the *P. contorta/S. canadensis* habitat type on the Routt National Forest. In the Bighorn Mountains, Hoffman and Alexander (1976) described an *Abies lasiocarpa/Shepherdia canadensis* habitat type which occurred on north-facing slopes, on the west side of the mountains. It

Figure 14.—Seral, old growth *Pinus contorta* in an *Abies lasiocarpa/Vaccinium scoparium* habitat type where *Picea engelmannii* is co-climax.

Figure 15.—*Pinus contorta/Shepherdia canadensis* habitat type. *Juniperus communis* is present at the left side of the photograph.

was characterized by the presence of *Vaccinium scoparium* beneath *Shepherdia canadensis*-dominated undergrowth. A similar habitat type was not observed in the Medicine Bow Mountains (Wirsing and Alexander 1975) or in Montana (Pfister et al. 1977).

Management implications.—The *Pinus contorta/ Shepherdia canadensis* habitat type is reasonably productive for timber, even though site indexes are likely to be average to below average (Alexander 1966). Even-aged management under either a clearcutting or shelterwood cutting alternative is recommended for most stands (Alexander 1974). A shelterwood system has the advantages of better meeting wildlife cover and visual management requirements while at the same time providing shade needed to conserve soil moisture and help control overstocking. It also provides some control over dwarf mistletoe, although clearcutting is a more effective silvicultural control. Clearcutting can result in either too much or too little reproduction, depending on the cone habit, amount of seed available, and slash disposal treatments (Alexander 1974). If a clearcut option is used in stands with nonserotinous cones, openings should be in the form of small 3- to 5-acre (1.24- to 2.02-ha) patches or narrow 400-foot (122 m) wide strips where natural regeneration is desired. Large clearcut openings will require fill-in planting. In stands with serotinous cones, clearcut openings up to 40 acres (16 ha) may be used if the stand is heavily infected with mistletoe. Care must be used in slash disposal in these stands so that the seed source is not destroyed.

Uneven-aged management under individual tree or group selection cutting can reduce stand susceptibility to mountain pine beetles by removing the most susceptible host trees. Group selection cutting is a possibility in stands with irregular structure, but individual tree selection in stands not attacked by mountain pine beetles is generally appropriate only in recreation areas. Growth will be substantially reduced, however, with either uneven-aged cutting method.

In young *P. contorta* pole stands, thinning is needed to reduce basal area and improve soil moisture conditions. Basal area levels of 120 to 160 are most appropriate for timber production (Alexander and Edminster 1980a).

Forage production is usually increased for a short time after clearcutting, but the potential for increasing forage production for either livestock or big game is limited in this habitat type.

Natural runoff in the *P. contorta/Shepherdia canadensis* habitat type is 10 to 15 inches (25 to 38 dm) annually. Much of the precipitation falls as snow. Streamflow can be substantially increased by clearcutting about one-third of the area in small patches interspersed with uncut timber. Other cutting methods are not likely to result in significant increases in natural runoff (Leaf 1975, Leaf and Alexander 1975).

Abies lasiocarpa Series

This series, represented by 36 plots, occupies the highest coniferous forest zone in the Routt National Forest (table 1). These forests—dominated by *Abies lasiocarpa* and *Picea engelmannii*—are usually referred to as the subalpine zone. In the Routt National Forest, as throughout much of the Rocky Mountains, the subalpine zone is widespread and supports forests of considerable importance. These forests are found on the Routt National Forest on all aspects. Stands sampled were from 7,760 to 10,000 feet (2,365 to 3,078 m) a span of 2,340 feet (713 m) elevation. This zone has been reported to be, generally, 2,000 feet (610 m) in elevational extent (Daubenmire 1943). In the Medicine Bow Mountains, Oosting and Reed (1952) reported spruce-fir vegetation occurred from 8,200 feet (2,500 m) in moist canyons to 11,600 feet (3,535 m). In the Routt National Forest, the lower elevational limits of *Abies lasiocarpa*-dominated forests and the upper elevational limits of the *Populus tremuloides*-dominated forests overlap, though aspect and soil play some part in the forest distribution.

The habitat types described in this series are all named for *Abies lasiocarpa* as the climax dominant to be consistent with common usage elsewhere (Daubenmire and Daubenmire 1968, Hoffman and Alexander 1976, Pfister et al. 1977, Reed 1976, Wirsing and Alexander 1975). In the Routt National Forest, *Picea engelmannii* is a co-climax dominant, with little evidence that it will ever be completely replaced by *A. lasiocarpa*. Young *A. lasiocarpa* usually outnumber the young *P. engelmannii*, because *A. lasiocarpa* is more tolerant and reproduces by both layering and from seeds, whereas *P. engelmannii* reproduces only from seed. Because *P. engelmannii* is long-lived, they are nearly always the larger trees in the stand. In most stands, *Pinus contorta* and *Populus tremuloides* are present as seral species. After disturbance, both *A. lasiocarpa* and *Picea engelmannii* can reestablish immediately with or without *Pinus contorta* and/or *Populus tremuloides*, depending on the type of disturbance and availability of seed or sprouting capacity.

Two habitat types were recognized in this series. Stands sampled ranged from 65 to more than 300 years old at breast height. Basal areas ranged from 126 to 340 square feet per acre (29 to 78 m^2/ha) (fig. 16). Tree sizes ranged from seedling to the 24- to 28-inch (6- to 7-dm) d.b.h. classes with an occasional tree in the more than 30-inch (8-dm) d.b.h. class. Tree population and undergrowth data are shown in appendix tables A-1, A-7 and A-9.

Abies lasiocarpa/Vaccinium scoparium

Description.—This habitat type, represented by 25 stands generally located on northwest-by-east and southwest-by-northwest aspects, is recognized by the almost constant presence and reproductive success of *Abies lasiocarpa* and by the abundance and understory dominance of *Vaccinium scoparium* with a constancy of 100% and an average coverage of 39% (fig. 17). *Picea engelmannii* is present as a self-reproducing co-climax species.

The overstory is dominated by *A. lasiocarpa* and *P. engelmannii*. *Pinus contorta* is an important seral species (fig. 18). *Populus tremuloides* is an occasional minor seral species. Ground cover which varies from sparse to lux-

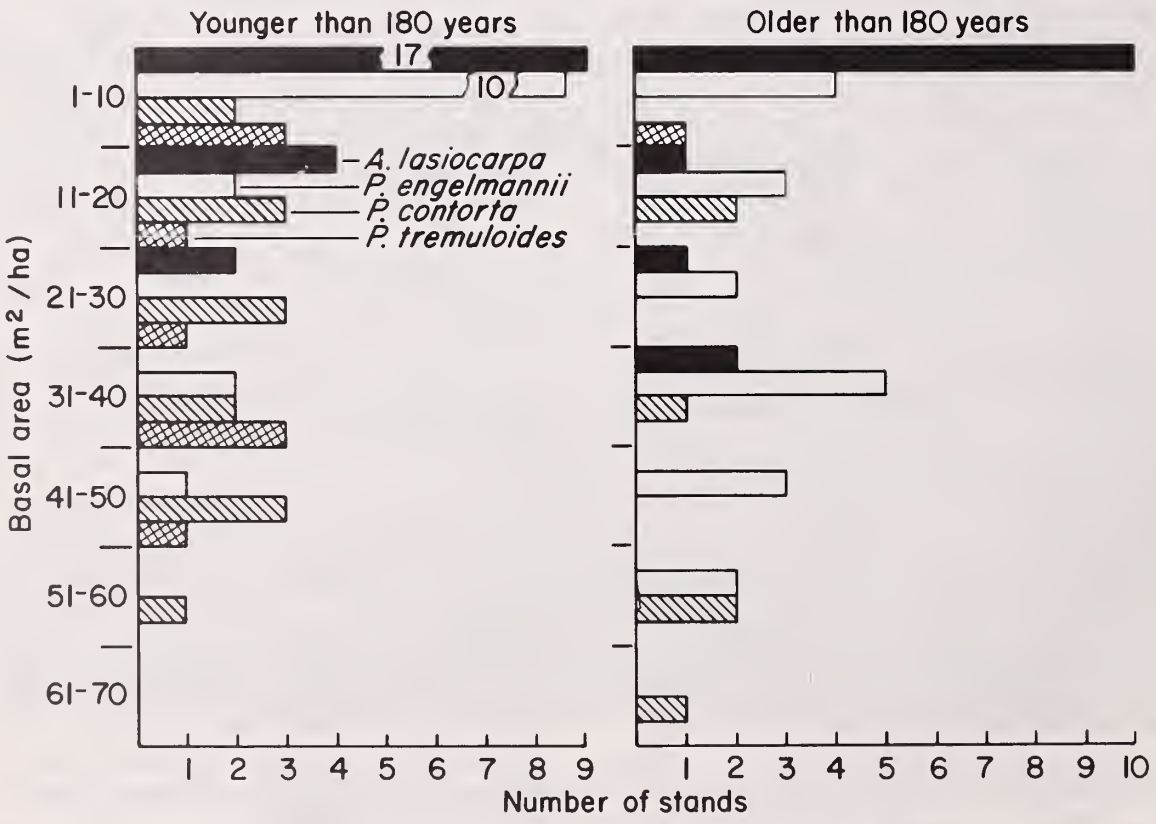

Figure 16.—Basal areas of tree species in *Abies lasiocarpa*-dominated habitat types. Data show relationships between stand age and numbers of stands in which species occur.

Figure 17.—*Abies lasiocarpa/Vaccinium scoparium* habitat type. *A. lasiocarpa* and *Picea engelmannii* are well represented in several size classes, including seedlings.

Figure 18.—*Abies lasiocarpa/Vaccinium scoparium* habitat type in which seral *Pinus contorta* still dominates the overstory. *A. lasiocarpa* and *Picea engelmannii* are the only self-reproducing tree species and will replace *Pinus contorta*.

uriant also includes the following important species: *Arnica cordifolia*, *Pachistima myrsinites*, *Ramischia secunda*, *V. myrtillus*, and *Carex geyeri* (fig. 19).

The *A. lasiocarpa/V. scoparium* habitat type, or others very similar to it, occur throughout a large region of the Rocky Mountains (Hoffman and Alexander 1976; Pfister et al. 1977; Steele et al. 1975, 1979; Wirsing and Alexander 1975). However, there is considerable variability in the coverage of *V. scoparium* within this habitat type. For example, more broad-leaved herbaceous dicots occur in this habitat type on the western slope of the Rockies than on the eastern slope.

Management implications.—Timber productivity varies considerably (Alexander 1967). Understory vegetation changes slowly after major disturbance, and competition is not severe between tree seedlings and understory vegetation, except where coverage of herbaceous dicots is high. There may be a manageable stand of advanced reproduction in much of this habitat type. While most silvicultural systems can be used (Alexander 1974), removal of the mature overstory in these mixed stands may result in an even-aged replacement stand of seral *Pinus contorta*, unless extreme care is taken in logging to protect advanced *Abies lasiocarpa* and *Picea engelmannii*. In mixed stands where *Pinus contorta* makes up part of the overstory, a shelterwood system that removes most of the *P. contorta* in the first cut can be used to maintain or increase the proportion of *A. lasiocarpa* and *Picea engelmannii* in the stand. Clearcutting is more likely to eliminate *P. engelmannii* on southerly exposures than on other aspects. Where protection from direct solar radiation and excessive soil moisture losses is necessary for survival of *P. engelmannii* seedlings, shelterwood is the only appropriate even-aged system. Uneven-aged management with group selection and/or individual tree selection cutting can be used in irregular-age stands, or where the combination of openings and high forest is required to enhance recreational opportunities and amenity values. Group selection is likely to perpetuate the existing species mix, while individual tree selection will favor *Picea engelmannii*, especially if the initial cutting removes a large proportion of *Pinus contorta*.

The *Abies lasiocarpa/Vaccinium scoparium* habitat type is not heavily used by livestock, but is big game summer range. It occupies areas with the greatest potential for water yield (up to 20 inches (50 cm) of natural runoff annually) in the Routt National Forest. Small patch (3- to 5-acre (1.24- to 2.02-ha)) or strip (400-foot (122-m)) clearcuts results in greater forage production for big game animals and larger increases in water available for streamflow than either shelterwood, group selection, or individual-tree selection cutting (Alexander 1977, Alexander and Edminster 1980b, Leaf 1975, Leaf and Alexander 1975, Regelin and Wallmo 1978, Wallmo 1969, Wallmo et al. 1972). Since forage production begins to decline in about 15 to 20 years, and water production in 20 to 30 years, new openings must be cut periodically to maintain these increases.

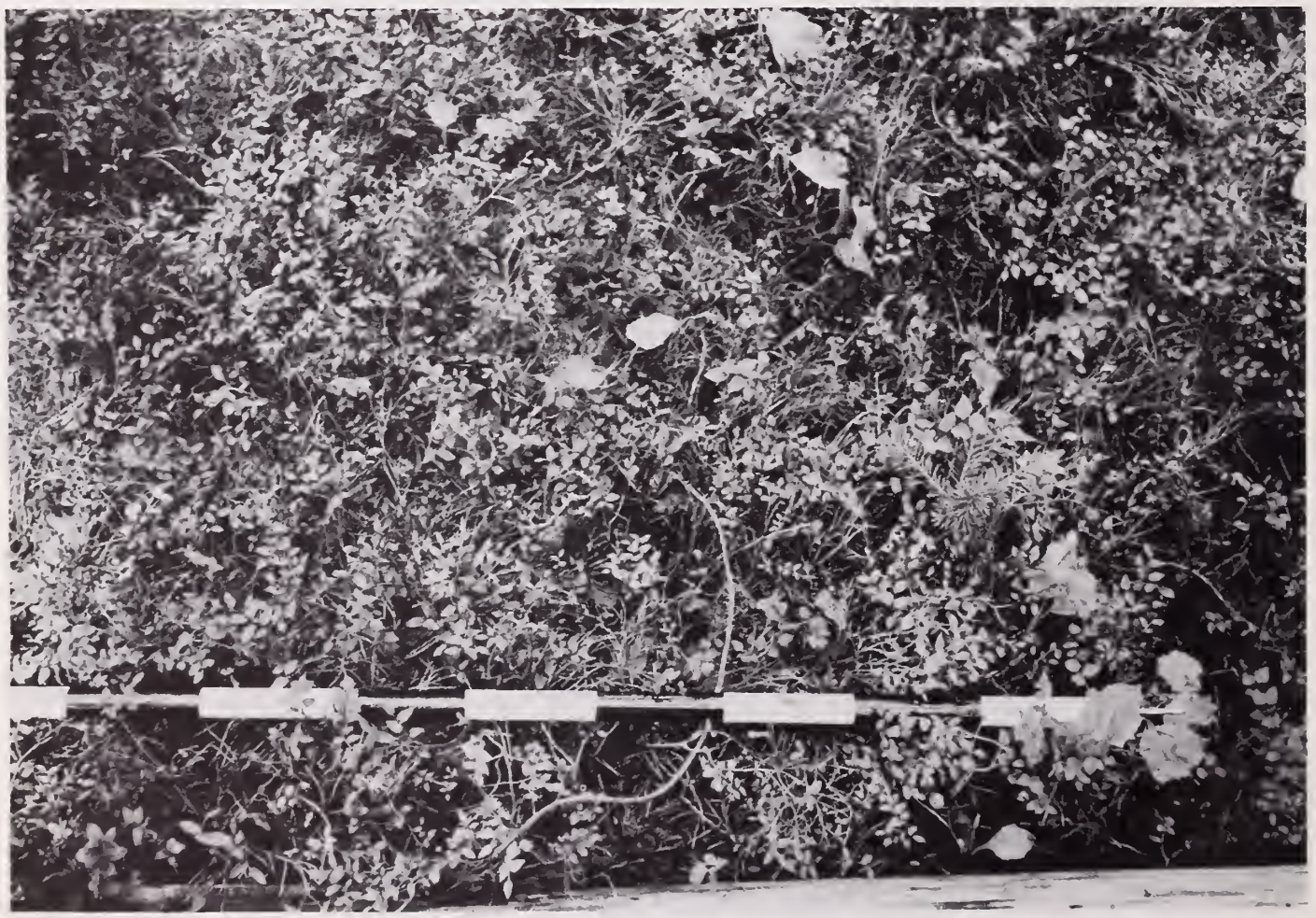

Figure 19.—Undergrowth in the *Abies lasiocarpa/Vaccinium scoparium* habitat type characteristically has few species, though *V. scoparium* is dense. *V. myrtillus*, *Arnica cordifolia*, and an *Abies lasiocarpa* seedling are also present in this stand.

Abies lasiocarpa/Carex geyeri

The *Abies lasiocarpa/Carex geyeri* habitat type, represented by 11 stands generally on northwest to south aspects, is distinguished by the dominance of *C. geyeri* in the undergrowth, the scarcity of *Vaccinium scoparium*, and the absence of *V. myrtillus* (fig. 20). The overstory dominants are *A. lasiocarpa* and *Picea engelmannii*. *Pinus contorta* and *Populus tremuloides* are seral species in most stands, with *P. tremuloides* a much more important seral species in the younger stands than in the *A. lasiocarpa/V. scoparium* habitat type; however, neither seral species shows any significant evidence of reproducing (fig. 21). Important undergrowth species in addition to *C. geyeri* are *Mahonia repens*, *Rosa* sp., *Pachistima myrsinites*, *Arnica cordifolia*, *Fragaria* sp., *Lathyrus leucanthus*, *Lupinus argenteus*, *Osmorhiza* sp., and *Vicia americana*.

This habitat type occurs at lower elevations and in drier situations than the *Abies lasiocarpa/Vaccinium scoparium* habitat type. Most stands were located at about 8,600 feet (2,620 m) on soils derived from a variety of parent materials. At higher elevations, the *A. lasiocarpa/C. geyeri* habitat type occurs on south and east slopes whereas the *A. lasiocarpa/V. scoparium* habitat type is generally on northwest to northeast slopes at upper elevations (fig. 22).

Steele et al. (1979) and Wirsing and Alexander (1975) reported an *A. lasiocarpa/C. geyeri* habitat type in Yellowstone National Park, the Teton National Forest, and the Medicine Bow Mountains, Wyoming, but it does not occur in the Wind River or Bighorn Mountains, Wyoming (Hoffman and Alexander 1976, Reed 1976). In Montana, an *A. lasiocarpa/C. geyeri* habitat type is a minor habitat type, occurring on cold, dry sites (Pfister et al. 1977). The habitat type does not occur in eastern Washington or northern Idaho (Daubenmire and Daubenmire 1968), but is common in central Idaho on granitic soils (Steele et al. 1975).

Management implications.—Understory vegetation in this habitat type recovers slowly from major disturbance. Reproduction in this dry, cold habitat type is likely to be more difficult to obtain, and competition between tree seedlings and understory vegetation is more severe than in the *A. lasiocarpa/V. scoparium* habitat type. Timber productivity is average to below average. Cutting methods applicable are similar to those suggested for the *A. lasiocarpa/V. scoparium* habitat type. Where there is an appreciable amount of either *Pinus contorta* or *Populus tremuloides* in the stands, clearcutting is likely to increase their representation in the new stand. This habitat type provides forage for livestock and big game. Heavy grazing may reduce the *Carex* cover and expose soils difficult to revegetate. Natural runoff (15 inches (38 cm)) is less than in the *A. lasiocarpa/ V. scoparium* habitat type, but can be increased significantly using the same cutting methods suggested for *A. lasiocarpa/V. scoparium* habitat type.

Figure 20.—*Abies lasiocarpa/Carex geyeri* habitat type. In this old-growth stand, there are only remnants of seral *Pinus contorta* present.

Figure 21.—*Abies lasiocarpa/Carex geyeri* habitat type. Seral *Pinus contorta* and *Populus tremuloides* dominate the overstory of this stand.

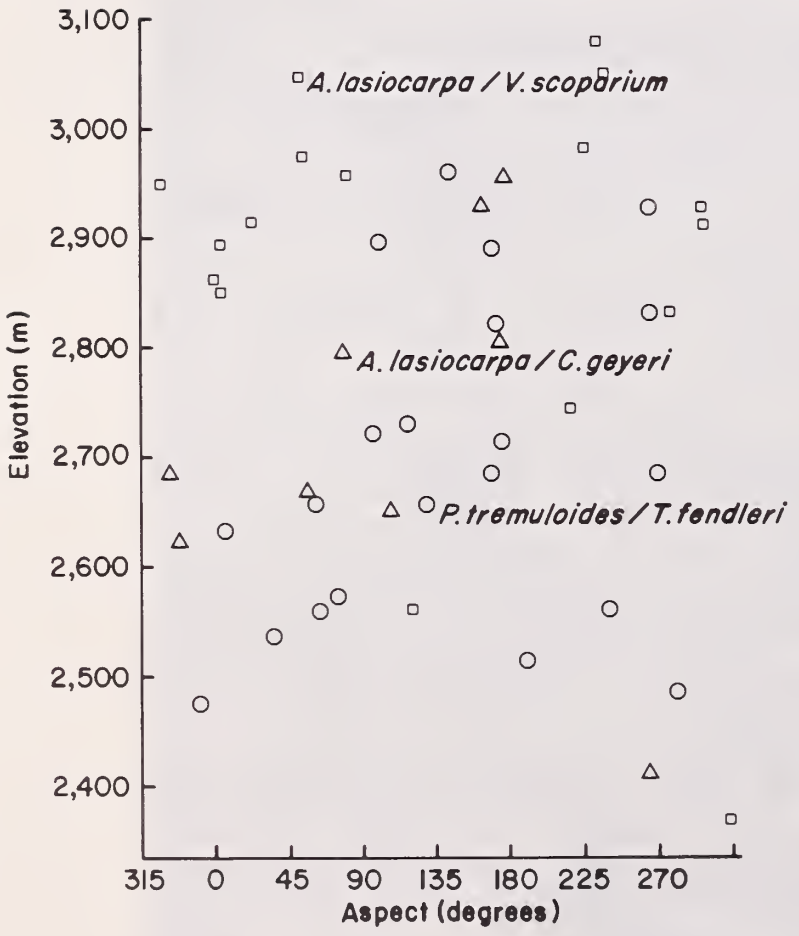

Figure 22.—Relationship of major habitat types to aspect and elevation on the Routt National Forest.

KEY TO THE FOREST HABITAT TYPES OF THE ROUTT NATIONAL FOREST

1. Conifers dominant and reproducing:

2. *Pinus flexilis* present; other conifers absent .... *PINUS FLEXILIS/ JUNIPERUS COMMUNIS* H. T.

2. Coniferous trees other than *Pinus flexilis* present and reproducing:

3. *Pinus contorta*, *Picea engelmannii*, and *Abies lasiocarpa* absent, or at least not reproducing. *Pseudotsuga menziesii* present and reproducing satisfactorily .... *PSEUDOTSUGA MENZIESII/ PACHISTIMA MYRSINITES* H. T.

3. *Pinus contorta*, *Picea engelmannii*, and *Abies lasiocarpa* present and may be reproducing; *Pseudotsuga* may be present but reproducing insufficiently to maintain its population:

4. *Pinus contorta* reproducing; no evidence of invasion by *Picea engelmannii* or *Abies lasiocarpa* .... *PINUS CONTORTA/ SHEPHERDIA CANADENSIS* H. T.

4. *Abies lasiocarpa* and/or *Picea engelmannii* dominant and reproducing. *Pinus contorta* and/or *Populus tremuloides* may be present but reproducing insufficiently to maintain population:

5. Undergrowth dominated by *Vaccinium scoparium* .... *ABIES LASIOCARPA/ VACCINIUM SCOPARIUM* H. T.

5. Undergrowth dominated by *Carex geyeri; Vaccinium scoparium* may be present but not dominant .... *ABIES LASIOCARPA/ CAREX GEYERI* H. T.

1. Conifers may be present but neither dominant nor reproducing suffciently to maintain their populations. Deciduous trees dominant and reproducing satisfactorily:

6. *Quercus gambellii* dominant. Other tree species absent or not dominant .... *QUERCUS GAMBELII/ SYMPHORICARPOS OREOPHILUS* H. T.

6. *Populus tremuloides* dominant; *Quercus gambelii* may also be present. Occasional conifer may also be present:

7. *Symphoricarpos oreophilus* dominant in undergrowth. *Amelanchier alnifolia* and *Prunus virginiana* may also be conspicuous .... *POPULUS TREMULOIDES/ SYMPHORICARPOS OREOPHILUS* H. T.

7. *Symphoricarpos oreophilus* may be present but not dominant in the undergrowth. *Amelanchier alnifolia* and *Prunus virginiana* absent or not abundant. Undergrowth characteristically a rich mixture of herbaceous species including *Thalictrum fendleri*, *Ligusticum porteri*, *Geranium richardsonii*, *Lathyrus leucanthus*, *Vicia americana*, *Bromus ciliatus*, and *Elymus glaucus:*

8. *Heracleum sphondyllium* the dominant species in the undergrowth .... *POPULUS TREMULOIDES/ HERACLEUM SPHONDYLLIUM* H. T.

8. *Heracleum sphondyllium* may be present but not dominant in the undergrowth:

9. *Veratrum tenuipetalum* dominant in the undergrowth .... *POPULUS TREMULOIDES/ VERATRUM TENUIPETALUM* H. T.

9. *Veratrum tenuipetalum* may be present but not dominant in the undergrowth:

10. *Pteridium aquilinum* dominant in the undergrowth .... *POPULUS TREMULOIDES/ PTERIDIUM AQUILINUM* H. T.

10. *Pteridium aquilinum* may be present but not dominant in the undergrowth ..... *POPULUS TREMULOIDES/ THALICTRUM FENDLERI* H. T.

The distribution and successional status of tree species in relation to habitat type are shown in figure 23.

DISCUSSION

Validity of Habitat Type Classification

This is one of a number of studies in the Rocky Mountain region to classify forests using the habitat type approach of Daubenmire and Daubenmire (1968). The validity of the habitat type classifications has been discussed by Daubenmire and Daubenmire (1968), Hoffman and Alexander (1976), and Pfister et al. (1977). The practical value of the habitat type classifications has only begun to be realized in areas of vegetation mapping, relation to tree growth, susceptibility to diseases, production of browse species for game animals, and in providing a framework within which to relate additional basic or applied biological studies.

The classification system, while using vegetation as the indicator of site potentials, draws together available related information on soil and climate. While initially using vegetation as the criterion of delimiting habitat types, this approach also takes a holistic view of units of land area. The older the stands observed, the more closely they approximate the potential (climax or near climax) of the landscape units studied (Daubenmire 1976).

This classification system utilizes both overstory and undergrowth vegetation in recognizing habitat types. In this study, the two major vegetation zones are dominated by *Populus tremuloides*, and *Abies lasiocarpa* and *Picea engelmannii.* It is apparent that the *Populus* zone on the Routt National Forest and elsewhere in Colorado is warmer and drier than the *Abies* zone. Edaphic factors are also more alike within than between zones.

The classification of habitat types recognizes climax tree species in an area; these are given primary consideration, and important seral species are noted. Undergrowth vegetation is then used to indicate habitat types within the zone where a given tree species is climax. Within the *Populus* zone of the Routt National Forest, five habitat types were recognized based on relatively few species. The *P. tremuloides/Thalictrum fendleri* and *P. tremuloides/Symphoricarpos oreophilus* habitat types are considered to be climatic climaxes. The *P. tremuloides/T. fendleri* habitat

Habitat type \ Species	*Pinus flexilis*	*Pseudotsuga Menziesii*	*Quercus gambelii*	*Populus tremuloides*	*Pinus contorta*	*Picea engelmannii*	*Abies lasiocarpa*
Pinus flexilis/Juniperus communis	C						
Pseudotsuga menziesii/Pachistima myrsinites		C	s	s			
Quercus gambelii/Symphoricarpos oreophilus			C				
Populus tremuloides/Symphoricarpos oreophilus			S	C			
Populus tremuloides/Heracleum sphondyllium				C			o
Populus tremuloides/Veratrum tenuipetalum				C		o	o
Populus tremuloides/Pteridium aquilinum				C			o
Populus tremuloides/Thalictrum fendleri				C	o	o	o
Pinus contorta/Shepherdia canadensis				o	C		o
Abies lasiocarpa/Vaccinium scoparium				s	S	C	C
Abies lasiocarpa/Carex geyeri				S	S	C	C

C = major climax species S = seral s = seral in some stands o = occasional

Figure 23.—Distribution of tree species through habitat types, showing dynamic status.

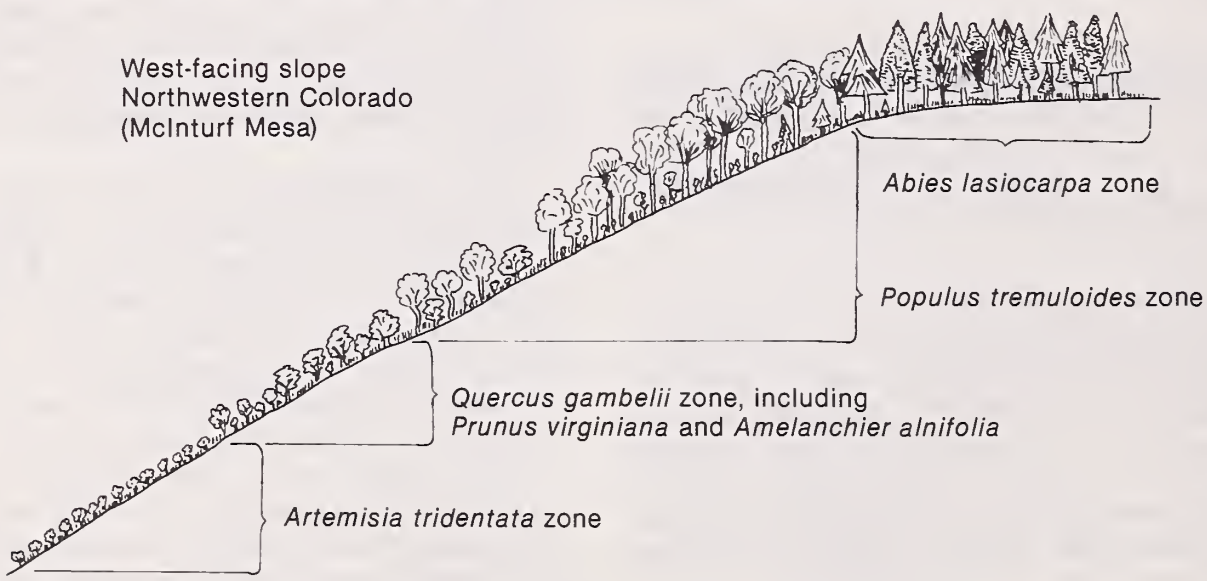

Figure 24.—An example of vegetation zonation on McInturf Mesa and above, Routt National Forest.

type occupies soils apparently developed through normal processes throughout most of the zone, and the *P. tremuloides/S. oreophilus* habitat type normally occupies soils developed in place at lower and drier edges of the zone. Throughout most of the *Populus*-dominated zone, there are restricted areas where combinations of edaphic and topographic characteristics allow *Heracleum sphondyllium*-, *Veratrum tenuipetalum*-, and *Pteridium aquilinum*-dominated undergrowth to establish under *Populus*. Although *P. tremuloides/T. fendleri* is the climatic climax throughout much of the *Populus* zone, undergrowth vegetation is expressed rather independently of the *P. tremuloides* overstory.

In the *Abies lasiocarpa* zone, the two habitat types, *Abies lasiocarpa/Vaccinium scoparium* and *Abies lasiocarpa/Carex geyeri*, are distinguished by differences in relatively few undergrowth species. However, the two habitat types also show some topographic and elevational differences. Additionally, *P. tremuloides* is an important seral species in the *A. lasiocarpa/C. geyeri* habitat type, but only a minor seral species in the *A. lasiocarpa/V. scoparium* habitat type.

Vegetation Zonation

An example of vegetation zonation in the Routt National Forest—McInturf Mesa and above—is shown in figure 24. *Pinus contorta* is not shown because of its restricted distribution as a climax species. *Pinus ponderosa* and *Pseudotsuga menziesii* were omitted because they are minor climax species in the Routt National Forest (fig. 25). The area depicted in figure 24 is typical in that *Artemisia tridentata*-dominated shrub-steppe is widely distributed at lower elevations. Shrub communities dominated by *Prunus virginiana* and *Amelanchier alnifolia* occur between the *Artemisia*-dominated vegetation, and the *Quercus gambelii*-dominated vegetation at higher elevations. In locations where neither the *Prunus/Amelanchier* and *Quercus* communities occur, *Artemisia* shrub-steppe extends to *Populus tremuloides*-dominated vegetation (fig. 26).

The absence of well defined *Pinus ponderosa* and *Pseudotsuga menziesii* zones over much of the area probably results from drought at low elevations and low temperatures at higher elevations. Despite Bates (1924) suggestion that *P. menziesii* may have occupied much of the lower elevations in the Routt National Forest, but was replaced by *Populus* following repeated fires, there are no data or field evidence available to corroborate this suggestion, even though there is evidence that fire played an important role in the establishment of *Populus* forests (fig. 27). Moreover, *Pseudotsuga menziesii* shows little tendency to establish in areas now occupied by *Populus tremuloides*. Nor are there relicts of *Pseudotsuga menziesii* in *Populus tremuloides* stands to suggest it was formerly present.

Populus tremuloides is a climax tree in five habitat types in the Routt National Forest. At its upper elevational limit, *Populus tremuloides* extends into the *Abies lasiocarpa* zone and there are numerous stands in which *Populus* is obviously seral to *Abies*. The subalpine forest, dominated by *A. lasiocarpa* and *Picea engelmannii* occurs from about 8,200 feet (2,500 m) to timberline.

Biotic Succession

The role of *Populus tremuloides* as a seral and/or climax species has been discussed at length by Baker (1925), Dixon (1935), Fetherolf (1917), Gardner (1905), Sampson (1925), and Youngblood (1979). Most investigators have agreed that *P. tremuloides* is an aggressive species on areas that have been burned, logged, or otherwise disturbed; it reproduces primarily by root suckers. There is less agreement on the stability of *P. tremuloides* once it is established. Data and observations from the present study suggest that both seral and climax stands of *P. tremuloides* occur in the Routt National Forest. Seral *Populus* stands are quite obvious where *Abies lasiocarpa* and *Picea engelmannii* are the climax species. In the *Pinus contorta/Shepherdia canadensis* habitat type, *Populus tremuloides* is only an occasional seral species. In *Abies*-dominated habitat types, either *Populus tremuloides* or *Pinus contorta* may become established first after disturbance or they may establish simultaneously. The availability of *Pinus* seed or *Populus* root sprouts determines which species initially becomes established.

Climax stands of *Populus tremuloides* show no clear evidence of successful conifer invasion. The presence of a limited number of coniferous seedlings in the undergrowth is insufficient evidence of succession. In addition, *Populus* usually has a stable population structure. The understory vegetation of the *Populus*-dominated habitat types is distinct, even though common species occur between *P. tremuloides*-dominated habitat types and other habitat types in the forest. Some soils differences exist between *Populus*-dominated and *Abies*-dominated habitat types. The oldest stand of climax *Populus*-dominated habitat types on the Routt National Forest was about 150 years old. If succession toward *Abies* and *Picea* forests is not evident in 150-year-old stands, they should be viewed and managed as climax forests.

Climax stands of *Pinus contorta* show no clear evidence of replacement by other conifers even though other seed sources are available. Moreover, climax *P. contorta* stands show a generally stable stand structure. The ability of *P. contorta* to remain dominant appears related to such topoedaphic factors as tolerance to intense solar radiation, nightly cold air accumulation and frost, and unstable and droughty soils.

In the *Abies lasiocarpa/Vaccinium scoparium* habitat type, *Populus tremuloides* is not an important seral species compared to *Pinus contorta*. In the *Abies lasiocarpa/Carex geyeri* habitat type, the reverse seems to be true. On the basis of observations made during this study, figure 28 is suggested as a working model of succession in *Abies*-dominated forests in the Routt National Forest. From the population structures of seral communities, it appears that any one of these three communities may become established and be succeeded by any one of the others before the *Abies*-dominated forest becomes established.

Species Richness

The median numbers of undergrowth species in stands of each habitat type are given in table 2. Starting at the lowest edge of the forest and moving upslope, ignoring all but apparent climatic climaxes, the maximum species richness is in the *Populus* zone (table 2). The relatively large number of undergrowth species in the *Abies lasiocarpa/Carex geyeri* habitat type reflects the large number of undergrowth species also common to the *Populus* zone. Tree species richness was greatest in *Abies*-dominated habitat types.

Species richness has also been reported for habitat types elsewhere in the Rockies. In the Wind River Mountains, it increased with increasing elevation (Reed 1969). In northern Idaho and eastern Washington, undergrowth species richness among climatic climaxes was greatest in mid-elevational habitat types dominated by *Pseudotsuga menziesii* and *Abies grandis*, and tree species richness was greatest in the *Abies lasiocarpa*-dominated habitat types (Daubenmire and Daubenmire 1968). In the Bighorn

Figure 25.—*Pinus ponderosa* is rare in the Routt National Forest. It is represented mainly by old, scattered individuals, but without evidence of reproduction.

FIgure 26.—*Populus tremuloides* invading into adjacent *Artemisia tridentata*-dominated shrub-steppe.

Figure 27.—Mosaic of vegetation types on an east slope, Routt National Forest. Sharp ecotones separating coniferous forest from *Populus tremuloides* forest suggest that *Populus* may have become established after fire. Different stand structures of *Populus*-dominated forests suggest continued spreading or establishment of new clones. Young *Populus* forms a fringe around the lower edge of the forest.

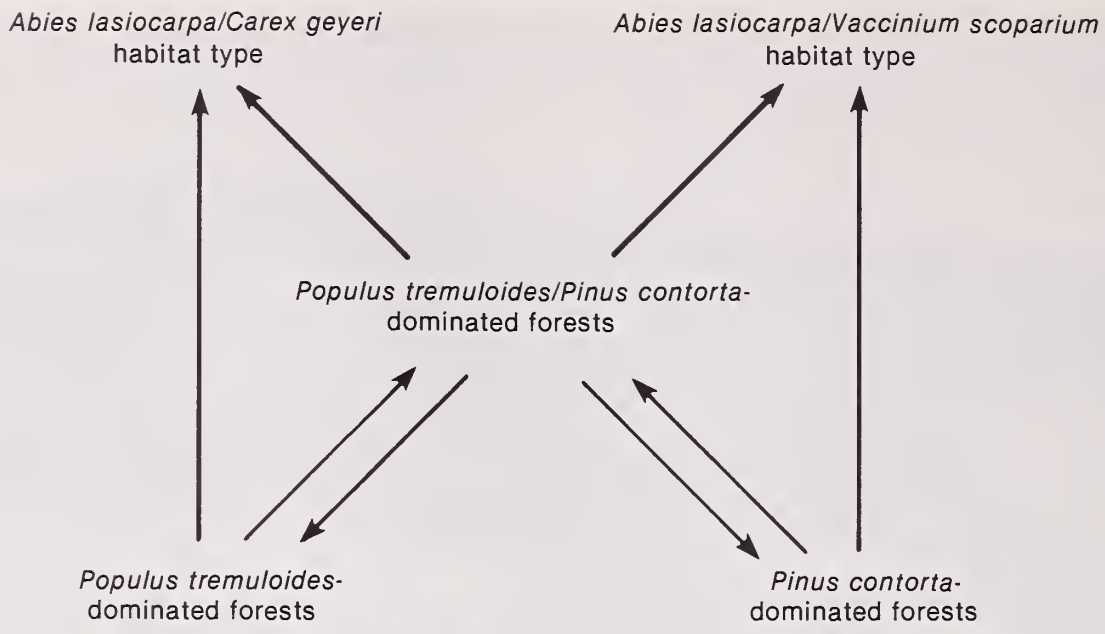

Figure 28.—Suggested succession in *Abies*-dominated forests in the Routt National Forest. The most apparent successional trends are shown by single arrows. Double arrows illustrate possible successional trends among the three different seral communities that occur—*Populus tremuloides, Pinus contorta,* and *Populus tremuloides/Pinus contorta.*

Table 2.—Species of undergrowth vegetation in habitat types of the Routt National Forest

Habitat type	Median number[1] of undergrowth species	Number of stands studied
Pinus flexilis/ Juniperus communis	17	3
Pseudotsuga menziesii/ Pachistima myrsinites	8	2
Quercus gambelii/ Symphoricarpos oreophilus	19	3
Populus tremuloides/ Symphoricarpos oreophilus	25	7
Populus tremuloides/ Thalictrum fendleri	27	26
Populus tremuloides/ Heracleum sphondyllium	23	4
Populus tremuloides/ Veratrum tenuipetalum	35	3
Populus tremuloides/ Pteridium aquilinum	30	7
Pinus contorta/ Shepherdia canadensis	15	6
Abies lasiocarpa/ Vaccinium scoparium	15	25
Abies lasiocarpa/ Carex geyeri	20	11

[1]*Based on 125 m² per stand.*

Mountains, greatest undergrowth species richness was in low and high elevation habitat types dominated by *Pinus ponderosa* and *Abies lasiocarpa*, respectively (Hoffman and Alexander 1976).

Further Studies in Relation to the Habitat Types

The present study was to provide a basic classification of the forest habitat types in the Routt National Forest. There are numerous areas of research which logically follow the present study.

The production of undergrowth vegetation in relation to habitat types needs to be examined. Ellison and Houston (1958), working in Utah, suggested that production of vegetation under *Populus tremuloides* could be used as an indicator of forage production and, therefore, range condition. In the Routt National Forest, both cattle and sheep utilize, sometimes quite heavily, vegetation under *Populus*. It would be valuable to know the relationship between habitat types and potential undergrowth productivity.

The growth rates of important timber trees may correlate with habitat types similar to the relationship of growth rates of *Pinus ponderosa* and the habitat types in the northern Rocky Mountains described by Daubenmire (1961).

Numerous fungi attack *Populus tremuloides* in Colorado (Juzwik et al. 1978). Some *Populus* habitat types may be more susceptible to various species of fungi than others are. In northern Idaho and eastern Washington, *Arceuthobium* infects *Pinus ponderosa* in the *P. ponderosa/Agropyron spicatum* and *P. ponderosa/Purshia tridentata* habitat types, but not in other habitat types dominated by *P. ponderosa* (Daubenmire 1961). There is a possibility that susceptibility of *Picea engelmannii* to insect infestation may be correlated with habitat types in Colorado (Shepherd 1959).

The relationship of forest habitat types and their successional stages to wildlife management also needs further research.

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APPENDIX

Table A-1.—Tree population structures for each habitat type. Numbers of trees listed are based on sample plot data of 375 m² per stand

Habitat type and species	Stands sampled	Mean basal area	Diameter (b.h.) classes in dm									
			0-1									Over
			<0.5	>0.5	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8
	number	*m²/ha*	*number of trees*									
Pinus flexilis/Juniperus communis	3	18.4										
Pinus flexilis			3	7	15	3	1	(1)	0	(1)	0	0
Quercus gambelii/Symphoricarpos oreophilus												
Quercus gambelii	3	23.2	538	53	32	1	(1)	0	0	0	0	0
Pseudotsuga menziesii/ Pachistima myrsinites	2	38.1										
Pseudotsuga menziesii			217	17	22	8	4	0	0	0	0	0
Populus tremuloides			38	1	2	0	0	0	0	0	0	0
Abies lasiocarpa			0	0	(1)	0	(1)	0	0	0	0	0
Quercus gambelii			4	2	2	(1)	0	0	0	0	0	0
Populus tremuloides/ Symphoricarpos oreophilus	7	24.4										
Populus tremuloides			46	14	27	10	(1)	0	(1)	0	0	0
Quercus gambelii			25	6	3	(1)	(1)	0	0	0	0	0
Populus tremuloides/Thalictrum fendleri	26	45.6										
Populus tremuloides			220	15	24	12	4	1	(1)	(1)	0	0
Pinus contorta			0	0	(1)	(1)	(1)	0	0	0	0	0
Abies lasiocarpa			7	(1)	(1)	(1)	(1)	0	0	0	0	0
Picea engelmannii			(1)	0	0	(1)	(1)	0	0	0	0	0
Populus tremuloides/Heracleum sphondyllium	4	41.2										
Populus tremuloides			301	7	8	16	5	(1)	(1)	0	0	0
Abies lasiocarpa			(1)	(1)	0	(1)	0	0	0	0	0	0
Populus tremuloides/Veratrum tenuipetalum	3	42.9										
Populus tremuloides			49	12	17	14	1	2	(1)	0	0	0
Pinus contorta			(1)	0	0	0	0	0	0	0	0	0
Abies lasiocarpa			22	0	0	0	0	0	0	0	0	0
Picea engelmannii			5	0	0	0	0	0	0	0	0	0
Populus tremuloides/Pteridium aquilinum	7	29.6										
Populus tremuloides			37	9	16	9	2	(1)	0	0	0	0
Abies lasiocarpa			6	(1)	(1)	0	0	0	0	0	0	0
Pinus contorta/Shepherdia canadensis	6	42.3										
Pinus contorta			39	13	27	11	2	(1)	0	0	0	0
Populus tremuloides			(1)	0	0	0	0	0	0	0	0	0
Abies lasiocarpa			14	0	0	0	0	0	0	0	0	0
Abies lasiocarpa/Vaccinium scoparium	25	49.8										
Abies lasiocarpa			182	6	6	2	(1)	(1)	(1)	0	0	0
Picea engelmannii			32	3	3	2	(1)	(1)	(1)	(1)	0	(1)
Pinus contorta			5	3	8	7	2	(1)	(1)	(1)	0	0
Populus tremuloides			2	(1)	(1)	0	0	0	0	0	0	0
Abies lasiocarpa/Carex geyeri	11	52.6										
Abies lasiocarpa			170	3	2	(1)	(1)	(1)	(1)	0	0	0
Picea engelmannii			51	(1)	2	(1)	(1)	(1)	(1)	0	0	(1)
Pinus contorta			1	3	5	5	4	(1)	(1)	0	0	0
Populus tremuloides			35	7	17	6	(1)	0	0	0	0	0

[1]*Species with less than 1.0 per d.b.h. class.*

Table A-2.—Location, topographic position, coverage (percent), and frequency (percent) of undergrowth species in stands of the *Pinus flexilis/Juniperus communis* habitat type

	Stand number		
	66	95	98
Location:			
Section	17	17	3
Township	11N	11N	9N
Range	81W	81W	81W
Topographic position:			
Slope	23%	30%	32%
Aspect	242°	238°	81°
Elevation (m)	2,609	2,615	2,530
	Coverage/Frequency		
Shrubs			
Artemisia tridentata	—	(1)/4	(1)/6
Cercocarpus montanus	—	—	0.6/12
Juniperus communis	7.6/16	4.9/8	5.2/14
Pinus flexilis	0.6/4	5.2/16	3.3/10
Purshia tridentata	—	—	(1)/4
Rhus trilobata	(1)/2	—	—
Ribes cereum	(1)/6	0.5/12	—
Sedum lanceolatum	—	(1)/6	(1)/8
Symphoricarpos oreophilus	(1)/2	—	—
Graminoids			
Agropyron trachycaulum	(1)/4	—	—
Festuca idahoensis	(1)/6	0.5/12	0.7/8
Koeleria cristata	(1)/4	—	(1)/2
Leucopoa kingii	1.2/8	0.6/4	1.6/12
Poa agassizensis	—	(1)/2	—
Poa nervosa	—	—	(1)/2
Stipa viridula	—	(1)/6	(1)/2
Stipa comata	(1)/2	—	(1)/4
Forbs			
Antennaria rosea	(1)/6	—	(1)/4
Arenaria congesta	(1)/4	0.5/16	—
Crepis acuminata	0.6/4	—	—
Drymocallis fissa	—	(1)/8	—
Erigeron flagellaris	0.6/4	—	—
Eriogonum umbellatum	—	(1)/4	0.8/8
Harbouria trachypleura	(1)/4	0.7/8	—
Lewisia rediviva	(1)/4	—	—
Phlox multiflora	—	(1)/6	(1)/8
Potentilla hippiana	(1)/4	—	—
Senecio fendleri	(1)/4	—	—
Zigadenus elegans	—	0.6/4	—
Lichens and mosses[2]	3.4/4	6.9/28	0.7/16
Total species	18	17	16
Total coverage (percent)	15.6	21.3	13.4

[1]*Coverage of less than 0.5%.*
[2]*Lichens and mosses are considered as one additional species.*

Table A-3.—Location, topographic position, coverage (percent), and frequency (percent) of undergrowth species in stands of *Pseudotsuga menziesii/Pachistima myrsinites* habitat type

	Stand number	
	94	99
Location:		
Section	35	24
Township	9N	6N
Range	85W	84W
Topographic position:		
Slope	42%	37%
Aspect	336°	348°
Elevation (m)	2,573	2,164
	Coverage/Frequency	
Shrubs		
Acer glabrum	11/40	5.6/28
Amelanchier alnifolia	2.8/16	1.2/12
Ceanothus velutinus	—	0.5/10
Mahonia repens	1.5/4	—
Moneses uniflora	—	(1)/6
Pachistima myrsinites	17/88	21/72
Populus tremuloides	0.6/4	—
Prunus virginiana melanocarpa	—	(1)/4
Pseudotsuga menziesii	1.1/18	0.6/12
Quercus gambelii	—	1.8/14
Ramischia secunda	(1)/8	—
Rosa woodsii	1.9/20	—
Sorbus scopulina	—	2.2/14
Symphoricarpos oreophilus	2.2/12	3.7/20
Vaccinium myrtillus	4.4/24	0.6/14
Vaccinium scoparium	—	(1)/8
Graminoids		
Bromus ciliatus	0.6/4	—
Calamagrostis rubescens	—	2.2/26
Carex geyeri	(1)/4	—
Poa nervosa	—	(1)/2
Forbs		
Arnica cordifolia	2.6/28	1.0/12
Aster engelmannii	1.5/4	1.2/6
Disporum trachycaulum	(1)/12	—
Epilobium angustifolium	0.6/4	0.5/6
Fragaria sp.	(1)/4	—
Lathyrus leucanthus	0.8/10	0.5/8
Osmorhiza sp.	(1)/12	0.6/18
Smilacina racemosa	0.7/8	—
Stellaria jamesiana	—	(1)/10

[1]*Coverage of less than 0.5%.*

Table A-4.—Location, topographic position, coverage (percent) and frequency (percent) of undergrowth species in stands of *Quercus gambelii/Symphoricarpos oreophilus* and *Populus tremuloides/Symphoricarpos oreophilus* habitat types

	Stand number									
	Quercus/ Symphoricarpos			*Populus/Symphoricarpos*						
	90	84	80	11	17	65	75	81	88	92
Location:										
Section	31	20	32	20	22	12	1	29	33	29
Township	9N	4N	8N	8N	3N	3N	9N	8N	7N	9N
Range	89W	85W	87W	87W	86W	87W	84W	87W	84W	89W
Topographic position:										
Slope	10%	35%	7%	—	30%	10%	32%	10%	18%	15%
Aspect	142°	296°	194°	—	61°	346°	152°	66°	124°	144°
	Coverage/Frequency									
Shrubs										
Abies lasiocarpa	—	—	—	—	(1)/2	—	—	—	—	—
Amelanchier alnifolia	2/20	11/24	(1)/4	4/24	25/78	0.7/6	1.8/6	22/52	11/60	0.6/4
Artemisia tridentata	—	0.6/4	(1)/2	—	—	—	—	—	—	—
Juniperus communis	(1)/4	—	—	—	—	—	—	—	—	—
Mahonia repens	—	—	—	—	1.1/6	—	5.7/40	0.6/4	2/40	—
Pachistima myrsinites	—	0.7/8	—	—	—	—	0.9/6	—	—	—
Populus tremuloides	—	—	—	—	—	—	—	(1)/2	—	(1)/4
Prunus virginiana	2.2/12	18/56	(1)/2	(1)/2	—	—	6.5/30	1.2/8	1.9/16	—
Quercus gambelii	5.4/40	6.1/32	17/36	—	—	—	—	(1)/4	(1)/4	2.2/12
Ribes montigenum	—	—	—	—	10/30	9.5/30	—	—	—	—
Rosa woodsii	—	0.7/8	—	(1)/4	1.4/6	—	(1)/2	2.1/8	1.6/8	11/36
Symphoricarpos oreophilus	22/72	50/92	4/24	40/82	10/44	30/76	29/62	11/28	16/60	(1)/12
Graminoids										
Agropyron inerme	—	—	0.9/8	—	—	—	—	—	—	—
Agropyron smithii	—	—	(1)/8	—	—	—	—	—	—	—
Agropyron trachycaulum	—	1.4/16	1/10	—	—	—	—	—	—	—
Bromus anomalus	—	1.2/18	—	—	—	2/8	—	(1)/2	—	—
Bromus ciliatus	—	4.2/24	7.6/32	2.4/26	14/56	12/60	1.1/14	3.6/28	1.4/16	1/20
Carex geyeri	44/92	3.7/16	—	—	3.2/12	1.6/8	44/94	1.2/8	10/40	25/84
Calamagrostis canadensis	—	12/56	—	—	—	(1)/2	—	—	—	0.9/16
Elymus glaucus	0.9/16	—	—	13/76	14/56	5.2/42	6.3/30	9.1/52	7/44	4.1/44
Melica spectabilis	—	—	(1)/4	—	—	1.5/18	0.9/16	(1)/4	1.5/20	—
Poa interior	1.8/16	0.6/4	2.6/64	10/68	(1)/4	5.6/36	—	—	—	2.6/14
Poa pratensis	3.6/28	—	28/72	18/56	1.3/12	9/48	—	(1)/4	—	6.2/60
Stipa lettermanii	—	1.2/8	—	—	—	—	—	—	—	—
Forbs										
Achillea millefolium	1.6/8	2.9/56	7.7/56	3.6/28	(1)/4	3.4/24	2.5/28	2.7/32	1.3/12	0.6/24
Actaea rubra	—	—	—	—	2.7/12	1.5/4	—	1.2/8	—	—
Agastache urticifolia	—	0.6/4	—	1.8/22	—	2.1/8	0.9/6	3.5/40	3/40	1.7/28
Antennaria rosea	—	—	—	—	—	—	0.6/4	—	—	—
Aquilegia coerulea	—	—	—	—	0.5/8	4.6/22	—	—	0.7/8	—
Arnica parryi	—	(1)/4	—	—	—	—	1.1/4	2.2/12	—	—
Aster engelmannii	—	—	—	—	—	(1)/2	0.6/4	0.6/4	4.4/24	—
Castilleja sulphurea	—	—	—	—	—	—	0.9/8	—	—	—
Cirsium sp.	0.7/8	—	—	—	—	(1)/2	5.2/26	—	1.8/12	—
Corallorhiza trifida	—	—	—	—	(1)/2	—	—	—	—	—
Delphinium barbeyi	—	—	—	1.1/6	—	—	—	—	—	(1)/4
Erigeron elatior	0.2/8	2.5/20	(1)/2	—	—	1.9/16	—	—	(1)/4	0.7/8
Erigeron speciosus	—	—	—	—	—	(1)/2	—	—	(1)/2	(1)/4
Eriogonum umbellatum	—	6.9/28	—	—	—	—	—	—	—	—
Fragaria sp.	—	—	—	—	(1)/4	(1)/2	—	—	—	—
Galium boreale	—	5.5/44	—	(1)/6	(1)/2	(1)/6	0.7/18	2.7/48	2.1/24	(1)/12
Geranium richardsonii and *caespitosum*	(1)/4	—	—	4.7/22	7/48	1.6/12	—	(1)/8	1.3/12	—
Heliomeris multiflora	—	—	—	—	—	—	—	—	(1)/12	—
Heracleum sphondyllium	—	—	—	—	—	(1)/2	—	—	—	—
Hydrophyllum capitatum	—	—	—	—	—	13/50	—	—	—	(1)/4
Lathyrus leucanthus	2.6/28	—	—	1.2/10	3.1/16	1.1/6	8.9/46	2.4/16	0.6/4	9.6/56
Ligusticum porteri	—	—	—	(1)/2	—	2.2/18	—	8.4/32	—	—
Lupinus argenteus ssp. *rubricaulis*	0.6/4	—	—	—	—	(1)/2	—	(1)/2	—	—
Osmorhiza sp.	(1)/2	—	—	0.5/8	17/84	11/52	7.3/40	7/44	1.4/16	7/48
Senecio crassulus	—	—	—	—	—	—	—	(1)/2	(1)/4	—
Smilacina racemosa	—	—	—	—	0.5/8	—	—	0.6/4	—	(1)/4
Stellaria jamesiana	—	1.3/12	(1)/8	(1)/2	—	1.1/16	—	3.2/48	(1)/8	—
Taraxacum sp.	—	—	—	0.6/12	4.9/32	1.2/18	0.6/6	—	(1)/4	—
Thalictrum fendleri	—	2.7/12	—	10/54	0.7/6	8.9/34	26/62	46/96	29/84	15/72
Thlaspi montanum	—	0.7/8	(1)/4	—	—	(1)/10	(1)/6	—	—	—
Thermopsis montana	—	—	—	—	—	—	—	0.6/4	—	—
Valeriana occidentalis	—	—	—	(1)/4	(1)/2	4.9/30	—	—	8.1/36	—
Vicia americana	0.7/8	(1)/4	(1)/4	1.3/10	0.6/4	4.1/18	8.6/44	9.9/48	2.5/20	—
Viola nuttallii	0.6/24	—	—	—	—	1.2/4	(1)/2	(1)/8	—	—
Wyethia amplexicaulis	4/24	—	4.4/24	—	—	—	—	—	—	—

[1]*Coverage of less than 0.5%.*

Table A-5.—Location, topographic position, coverage (percent), and frequency (percent) of undergrowth species in stands of the *Populus tremuloides/Thalictrum fendleri* habitat type

	Stand number																									
	39	6	21	22	23	26	42	69	74	27	35	91	12	38	78	79	9	10	13	14	67	70	76	19	77	72
Location: Section	10	20	15	30	31	14	29	23	21	31	15	20	23	22	27	10	32	33	9	2	17	25	6	36	36	21
Township	5N	3N	1N	3N	3N	2N	3N	3N	2N	10N	9N	10N	10N	9N	10N	10N	11N	11N	11N	10N	11N	10N	9N	7N	7N	7N
Range	80W	87W	86W	86W	86W	88W	87W	86W	88W	87W	89W	88W	87W	87W	87W	87W	85W	85W	85W	86W	85W	84W	83W	83W	84W	82W
Topographic position:																										
Slope	19%	25%	—	—	—	20%	40%	15%	19%	—	28%	14%	7%	5%	11%	12%	—	24%	30%	33%	9%	6%	20%	12%	29%	15%
Aspect	286°	171°	—	—	—	96°	261°	100°	141°	—	116°	238°	76°	352°	66°	38°	—	131°	6°	176°	280°	172°	190°	171°	270°	58°
Elevation (m)	2,829	2,819	2,576	2,737	2,835	2,719	2,926	2,896	2,957	2,804	2,731	2,560	2,573	2,475	2,560	2,536	2,682	2,658	2,633	2,713	2,487	2,682	2,512	2,890	2,682	2,652
	Coverage/Frequency																									
Shrubs																										
Abies lasiocarpa	—	—	—	—	5.1/12	—	—	3.1/10	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Amelanchier alnifolia	—	—	—	—	—	—	—	—	—	—	1.4/8	—	—	—	—	—	—	—	—	—	0.8/2	—	—	—	0.8/2	—
Mahonia repens	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4.4/36	—	—	0.6/4	—	1.1/4	—	—	—
Pachistima myrsinites	—	(1)/6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	(1)/2	—	—	—	—	—	—	—	—
Populus tremuloides	—	—	6.2/28	5.2/22	3.9/14	—	0.9/6	3.7/22	—	—	—	0.5/10	—	4/38	—	1.7/8	—	—	—	—	—	1.2/8	—	—	—	(1)/4
Prunus virginiana	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1.7/2	—	—	—	—	—
Ribes montigenum	—	—	(1)/2	—	—	—	—	—	(1)/2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Rosa woodsii	—	1.8/14	—	4/30	—	—	—	2.1/14	—	—	—	(1)/4	—	—	—	—	—	(1)/4	—	—	2.1/16	(1)/2	—	—	—	2.2/12
Rubus parviflorus	—	—	—	—	(1)/4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	24/48	—
Sambucus racemosa	—	—	—	—	—	—	—	—	—	—	—	—	—	0.8/2	—	—	—	—	—	—	—	—	—	—	—	—
Sorbus scopulina	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.6/4	—
Symphoricarpos oreophilus	—	(1)/6	—	4.5/10	—	—	6/18	—	—	—	—	—	—	2.5/4	(1)/2	(1)/2	—	—	—	—	2/16	—	12/36	—	—	6.6/22
Vaccinium myrtillus	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	6/20	—
Graminoids																										
Agropyron elongatum	(1)/2	—	—	(1)/2	—	—	(1)/4	—	—	—	—	—	—	—	—	—	—	—	—	—	(1)/2	—	0.6/4	—	—	—
Agropyron inerme	—	—	(1)/2	—	—	—	—	(1)/4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.6/6	—	—
Agropyron trachycaulum	—	—	—	—	(1)/2	—	—	—	—	—	—	(1)/2	—	—	(1)/2	—	0.6/4	—	—	—	—	—	—	—	—	—
Bromus anomalus	—	1.2/14	—	—	(1)/8	5.2/38	—	0.8/16	0.6/10	2/22	2.3/28	0.6/14	—	0.8/12	—	—	0.4/10	—	(1)/6	1.2/34	(1)/4	0.8/14	—	5.2/24	—	—
Bromus ciliata	11/62	5/28	3.8/20	9/58	4.4/22	21/86	5.1/30	20/80	(1)/4	16/54	1.3/22	14/86	—	8.6/48	5/24	2/18	11/52	—	—	3.6/28	7.3/42	27/92	4.6/28	16/74	—	3.5/22
Calamagrostis canadensis	(1)/4	—	—	—	—	—	—	—	—	—	(1)/2	—	—	—	—	—	—	—	—	—	—	—	—	(1)/6	—	—
Calamagrostis rubescens	—	—	—	—	—	—	—	—	—	—	—	—	2.6/24	—	—	—	—	38/78	30/66	1.5/4	—	—	—	—	—	—
Carex geyeri	22/62	42/94	20/58	29/80	—	(1)/2	9.2/26	17/58	—	(1)/2	25/72	2.8/6	13/62	—	—	—	—	1.8/14	(1)/8	—	3.0/22	—	—	—	20/68	48/100
Carex hoodii	—	—	—	—	—	(1)/2	—	—	—	—	(1)/2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Carex raynoldsii	—	—	—	—	—	—	(1)/4	—	—	—	—	—	1.4/16	—	—	—	—	—	(1)/4	—	—	—	—	—	—	—
Carex sp.	—	—	—	(1)/2	—	—	—	—	(1)/2	(1)/4	—	—	—	—	—	—	—	—	(1)/2	—	(1)/2	—	—	—	—	—
Elymus glaucus	(1)/4	10/46	1.4/6	6.4/42	20/78	20/60	6.2/36	0.8/4	17/68	7.1/32	21/76	11/70	12/64	35/88	16/80	11/68	3.2/32	1/18	26/96	21/98	17/74	(1)/2	9.9/64	8.1/56	11/46	1.6/12
Melica spectabilis	—	—	—	—	—	—	(1)/2	(1)/2	0.7/16	1.7/10	(1)/2	—	(1)/2	—	2.4/28	0.9/16	—	—	—	(1)/4	1/10	7.1/46	1.7/18	(1)/6	—	(1)/4
Phleum pratense	—	—	—	—	—	(1)/2	—	(1)/2	—	—	—	0.6/4	—	—	1.4/8	1.3/12	0.8/20	—	—	—	2.1/8	(1)/2	1.6/12	—	—	—
Poa canbyi	3.2/14	—	—	—	—	(1)/6	—	—	0.8/10	—	—	—	—	—	—	1.2/16	—	—	—	(1)/2	—	—	—	—	—	—
Poa interior	0.6/10	—	1.2/14	—	6.6/48	—	0.6/6	0.8/4	2.2/18	—	—	—	0.9/16	—	(1)/4	—	2.5/30	—	—	3.5/36	4.2/30	—	—	1.5/22	—	—
Poa leptocoma	—	(1)/2	—	—	—	(1)/8	—	—	—	3.8/38	—	—	(1)/4	—	—	—	0.8/14	—	—	0.8/10	—	0.6/8	—	—	—	—
Poa nevadensis	—	—	0.6/12	2.4/30	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1.8/28	—	0.5/8	—	—
Poa pratensis	—	—	14/48	4.3/28	—	—	—	—	—	(1)/6	(1)/2	—	3.7/34	4.4/20	—	—	—	6/30	5.2/28	—	—	6.7/46	—	1.1/20	—	—
Trisetum spicatum	—	—	—	—	—	—	—	—	—	(1)/2	—	—	—	—	—	—	—	—	—	—	—	—	—	(1)/4	—	—
Forbs																										
Achillea millefolium	—	0.8/10	(1)/2	0.8/10	—	(1)/2	2.8/32	1.3/20	—	—	0.6/14	(1)/12	4.7/42	—	7.1/40	4.2/22	8.9/46	—	0.5/8	—	3.1/24	(1)/4	3.5/24	—	—	9.6/58
Aconitum columbianum	—	—	—	—	3.4/28	2.1/18	—	(1)/4	—	(1)/2	0.5/8	—	—	—	0.8/10	—	—	(1)/4	—	—	—	1.1/6	1.8/8	—	—	(1)/2
Actaea rubra	2.2/4	—	—	—	(1)/2	—	(1)/4	—	—	—	—	—	—	—	—	—	—	—	—	—	(1)/4	—	—	—	—	—
Agastache urticifolia	—	—	—	—	—	3.3/16	6.2/36	—	—	(1)/4	—	—	—	—	1.1/12	—	—	—	—	(1)/2	0.8/10	2.5/20	3.9/26	—	—	—
Androsace septentrionalis puberulenta	—	—	—	(1)/2	—	(1)/2	(1)/12	—	1.9/16	0.8/10	—	—	—	—	0.3/2	—	(1)/2	—	—	—	—	(1)/4	(1)/2	1.3/12	—	—

Aquilegia caerulea	—	—	1.1/12	—	—	—	(¹)/2	—	(¹)/2	3/14	—	—	—	—	—	—	—	—	0.5/10	—	(¹)/2	0.6/4	6/26	—	1.3/2	—
Arabis drummondii	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	(¹)/2	—	—	—	—
Arnica cordifolia	—	—	3.6/18	3.9/14	—	—	—	—	—	—	1/18	—	—	—	—	—	(¹)/2	18/80	52/100	—	4.8/18	—	—	—	2/10	22/66
Arnica parryi	—	—	—	—	(¹)/4	—	—	—	—	—	—	—	—	—	0.9/6	—	—	(¹)/4	—	—	—	—	7.2/28	—	—	—
Aster engelmannii	—	—	—	1.4/16	—	2.8/16	4/14	(¹)/4	4.5/26	2.1/16	11/66	(¹)/4	—	(¹)/2	8.6/42	(¹)/2	—	—	2.4/24	—	—	(¹)/2	1.7/8	—	15/70	0.6/14
Castilleja sulphurea	—	—	—	(¹)/2	—	—	—	8.1/44	—	—	—	—	—	—	—	—	—	(¹)/2	—	—	—	—	—	—	—	0.6/12
Chenopodium atrovirens	—	—	—	—	—	1.7/10	1/12	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Cirsium sp.	—	—	0.7/6	1.3/12	—	—	—	2.3/12	3.9/20	—	—	1/8	—	—	(¹)/2	—	—	—	—	—	—	—	2.1/14	—	—	—
Collomia linearis	—	—	—	—	—	—	0.6/12	—	—	—	—	—	(¹)/2	—	—	—	—	—	—	—	—	—	(¹)/2	—	—	—
Delphinium barbeyi	(¹)/2	—	—	—	12/50	23/54	(¹)/2	—	6.6/26	7.1/18	—	2.5/28	—	4.7/24	4.2/10	1.2/10	(¹)/2	—	—	—	1.4/18	—	—	—	—	—
Delphinium nelsonii	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1.6/14	7.8/26	(¹)/2	—	—
Descurainia californica	—	—	—	—	—	1.3/12	1.5/10	—	—	(¹)/4	—	—	(¹)/2	—	(¹)/2	—	—	—	—	—	—	—	—	—	—	—
Epilobium angustifolium	1.1/12	—	—	(¹)/2	—	—	—	—	—	—	(¹)/2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Erigeron elatior	—	0.7/8	—	—	(¹)/2	1.7/8	1.6/10	1.2/10	2.9/10	—	—	(¹)/2	—	—	3.2/20	—	—	—	—	1/8	—	2/20	5.8/24	5.7/36	(¹)/6	(¹)/2
Erigeron speciosus	—	—	—	(¹)/4	—	—	—	—	—	0.7/8	—	(¹)/6	—	(¹)/4	—	—	—	0.5/6	—	—	—	—	—	—	(¹)/2	—
Fragaria sp.	—	—	(¹)/12	1.2/16	0.5/8	—	—	19/86	—	—	0.7/8	4.9/64	1.3/30	0.9/16	(¹)/6	14/66	1.1/12	2.2/12	—	—	3.4/36	—	5.1/48	—	—	—
Galium aparine	—	—	—	—	0.6/4	—	—	—	—	—	—	—	—	(¹)/2	—	—	—	—	—	—	—	—	—	—	—	—
Galium boreale	(¹)/10	1.0/10	1.4/14	4.2/38	1.8/30	—	—	—	3.6/44	—	1.3/20	3/40	0.5/8	0.9/6	—	—	(¹)/2	—	—	—	—	7.8/56	(¹)/6	—	—	(¹)/2
Geranium nervosum	—	—	—	—	—	(¹)/4	—	—	—	—	—	—	2.4/14	—	—	(¹)/2	—	—	1.6/6	—	0.8/10	—	—	—	1.1/6	—
Geranium richardsonii	4/30	45/98	—	—	8.6/52	6.1/24	(¹)/6	—	16/44	10/52	(¹)/6	11/78	6.6/44	3.2/32	7.2/54	13/68	5.6/24	—	5.2/34	8.5/44	10/78	5.2/18	5.4/34	5.1/14	—	—
Geum allepicum	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.5/10	—	—	—	—	—	—	—	—	—
Helenium hoopesii	—	—	—	—	—	—	3.6/10	—	—	—	—	—	—	—	—	—	—	—	0.6/4	—	—	—	—	—	—	(¹)/2
Heliomeris multiflora	—	—	—	0.8/6	—	(¹)/4	0.8/2	—	—	—	—	—	—	—	—	(¹)/2	—	—	—	—	—	—	—	4.8/32	—	—
Heracleum sphondyllium	—	—	—	—	1.3/14	—	—	—	—	12/32	—	—	—	1.8/14	(¹)/2	0.7/8	—	—	—	13/34	—	—	(¹)/2	—	—	—
Hydrophyllum capitatum	4.4/30	—	—	—	(¹)/4	6.1/32	—	—	22/64	—	—	—	—	—	—	—	—	—	—	—	—	5.5/34	(¹)/4	(¹)/2	—	—
Lathyrus leucanthus	8.5/42	16/64	0.7/6	0.7/8	—	2.3/12	7.3/40	34/92	7.2/38	0.7/6	2.9/16	4.6/26	6.3/36	—	1.2/8	0.6/10	19/62	16/64	9.8/64	1.2/8	2/20	13/64	1.4/6	8.1/50	19/64	—
Ligusticum porteri	—	5/20	38/86	—	13/50	18/56	7.2/20	—	41/76	36/72	18/40	17/56	3.5/14	20/44	29/70	12/36	—	—	—	—	23/58	2.3/6	2.3/6	—	34/86	18/44
Lupinus argenteus rubricaulis	—	(¹)/2	—	3.1/24	3.1/8	—	—	5.3/44	—	—	2.8/16	(¹)/2	(¹)/4	—	3.1/16	—	5.6/30	—	—	—	—	3.1/28	3.1/24	4.4/30	(¹)/8	(¹)/2
Mertensia ciliata	—	—	—	—	(¹)/8	—	—	—	0.8/4	—	—	—	—	(¹)/2	—	—	—	—	—	—	—	—	—	—	—	—
Nemophila breviflora	—	—	—	—	—	—	—	—	4.3/26	0.5/18	—	—	—	—	—	—	1.9/16	—	—	—	(¹)/2	5/32	—	—	—	—
Osmorhiza sp.	11/52	5.3/30	(¹)/2	1.4/14	1.1/22	2/50	11/40	—	5.3/14	3.7/23	7.3/40	11/44	1.3/10	7/46	12/36	5.5/30	(¹)/4	—	(¹)/2	11/42	8.8/34	6.1/30	5.4/16	0.8/4	(¹)/4	—
Pedicularis procera	—	—	—	—	0.6/4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Penstemon whippleanus	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	(¹)/2	—	—
Polygonum douglasii latifolium	—	—	—	—	—	—	3.1/46	—	(¹)/2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Potentilla arguta	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	(¹)/4	—	—	—	—	—	—	—	—	(¹)/2
Potentilla gracilis	—	—	—	—	—	—	—	—	—	—	—	(¹)/2	(¹)/2	—	(¹)/2	—	—	—	—	—	(¹)/4	—	1.9/16	—	—	—
Potentilla quinquefolia	—	—	—	—	—	—	—	0.7/6	—	—	—	(¹)/2	—	—	—	—	—	(¹)/2	—	—	(¹)/4	—	—	—	(¹)/4	—
Potentilla norvegica	—	(¹)/2	—	—	—	—	—	—	—	—	—	—	—	—	—	(¹)/4	—	—	—	—	—	—	—	1.8/20	—	—
Pteridium aquilinum	—	(¹)/4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Ranunculus inamoenus	—	—	—	—	—	—	—	—	—	(¹)/2	—	—	—	—	—	—	(¹)/4	—	(¹)/8	—	1/10	—	1.2/16	—	—	—
Ranunculus uncinatus parviflorus	—	—	—	—	—	—	—	—	(¹)/6	(¹)/2	—	—	2.3/22	—	2/20	1.9/26	(¹)/12	—	—	0.5/8	—	3.7/38	(¹)/2	(¹)/2	—	—
Senecio crassulus	—	—	—	—	—	—	—	1.1/4	(¹)/2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	(¹)/2
Senecio serra	17/56	—	—	—	—	1.5/10	(¹)/4	1.5/10	2.2/18	4.8/20	(¹)/2	—	—	2.3/14	—	—	—	—	—	0.5/8	—	2.2/12	0.8/2	—	—	—
Silene menziesii	(¹)/4	(¹)/2	—	—	—	4/40	—	(¹)/4	—	1.4/14	—	—	—	—	—	—	—	—	—	0.7/18	—	(¹)/2	—	—	—	—
Smilacina racemosa	0.8/12	(¹)/2	—	—	0.7/8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Solidago spathulata	—	—	—	1/10	0.6/4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Steliaria jamesiana	—	(¹)/2	—	—	—	4/30	3.5/40	—	—	6/38	0.7/18	0.7/6	(¹)/4	—	2.7/28	1.6/26	—	—	—	—	1.8/22	—	—	4.8/64	—	(¹)/6
Streptopus amplexifolius	—	—	(¹)/4	—	—	—	—	(¹)/4	—	—	—	—	—	—	—	—	—	—	(¹)/4	—	—	—	—	—	—	—
Taraxacum sp.	0.6/4	—	0.5/10	0.7/6	(¹)/2	—	(¹)/2	2.2/26	(¹)/2	(¹)/2	—	2.3/22	2.6/24	—	4.8/40	8.8/50	2.3/22	—	—	—	1/10	—	—	—	—	(¹)/2
Thalictrum fendleri	63/100	29/86	26/70	20/50	—	16/52	32/78	—	6/26	6.8/15	22/84	45/86	5.4/30	11/50	34/82	7.4/18	1.1/4	11/32	2.7/10	56/98	33/86	—	31/66	6.8/14	5/26	10/22
Thermopsis montana	—	—	—	—	—	—	—	—	—	—	10/48	(¹)/2	15/54	—	—	1.1/6	—	—	—	—	—	—	—	—	—	—
Thlaspi montanum	—	—	—	—	—	—	—	—	5.7/50	—	—	—	—	—	—	(¹)/2	—	—	—	1.6/32	—	7.8/56	1.3/22	—	—	—
Trillium ovatum	—	—	—	—	—	—	—	—	—	—	(¹)/6	—	—	—	(¹)/2	0.6/26	(¹)/6	—	—	—	—	0.8/14	0.6/4	—	3.3/36	—
Valeriana occidentalis	—	—	—	—	1/10	(¹)/4	—	—	2.9/12	4.7/24	2.7/18	8.5/42	—	0.6/4	25/66	13/50	2.7/18	—	—	—	6.1/40	15/42	24/66	—	—	—
Veratrum tenuipetalum	—	—	—	—	8.6/22	—	—	—	(¹)/2	(¹)/4	—	—	—	—	1.1/6	6.3/22	—	—	—	—	—	—	—	—	—	—
Vicia americana	2.2/12	1.2/18	—	24/62	—	(¹)/6	1/8	4.7/40	—	(¹)/2	4.8/28	1.4/6	16/68	0.7/6	6/30	4.2/22	12/48	31/88	13/52	1.5/20	9.3/50	0.7/6	10/46	6.5/38	8.3/42	36/92
Viola canadensis	—	—	—	—	—	—	(¹)/2	—	—	—	—	(¹)/4	—	—	—	—	—	—	—	—	—	—	—	—	0.6/12	—
Viola nuttallii	(¹)/2	—	—	—	(¹)/2	—	0.6/14	—	2.3/22	1.3/20	(¹)/4	0.5/10	0.9/14	5.6/56	2.8/28	3.8/30	1/10	—	—	0.8/24	—	1.2/20	—	3.2/30	3.7/48	2.3/24
Zigadenus elegans	—	—	—	—	(¹)/2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

¹Coverage of less than 0.5%.

Table A-6.—Location, topographic position, coverage (percent), and frequency (percent) of undergrowth species in stands of *Populus tremuloides/Heracleum sphondyllium, P. tremuloides/Veratrum tenuipetalum,* and *P. tremuloides/Pteridium aquilinum* habitat types

	Stand number													
	Populus/ Heracleum				*Populus/ Veratrum*			*Populus/Pteridium*						
	20	37	8	49	5	62	71	24	59	18	89	36	52	53
Location:														
Section	12	22	12	2	30	20	25	36	26	27	26	15	15	15
Township	1N	9N	10N	10N	3N	9N	10N	5N	5N	7N	7N	9N	9N	9N
Range	86W	87W	86W	86W	86W	84W	84W	84W	84W	84W	84W	89W	89W	89W
Topographic position:														
Slope	27%	5%	21%	29%	—	—	18%	29%	33%	4%	25%	20%	30%	28%
Aspect	216°	356°	201°	181°	—	—	186°	181°	196°	336°	322°	86°	106°	106°
Elevation (m)	2,444	2,475	2,606	2,688	2,682	2,682	2,682	2,682	2,475	2,512	2,548	2,755	2,743	2,731
	Coverage/Frequency													
Shrubs														
Abies lasiocarpa	—	—	—	—	—	—	0.8/2	—	—	—	—	—	(1)/2	—
Amelanchier alnifolia	—	—	—	—	—	—	—	—	6.8/30	—	—	—	7/30	1.3/2
Lonicera involucrata	—	—	—	—	—	—	—	—	—	2/4	—	—	—	—
Mahonia repens	—	—	—	—	—	—	—	—	2.4/16	—	—	—	(1)/4	—
Pachistima myrsinites	—	—	—	—	—	—	—	6.7/22	(1)/2	—	—	—	—	—
Populus tremuloides	—	1/8	—	6.6/26	—	1.5/4	(1)/4	—	—	—	—	—	3.4/12	1.2/2
Prunus virginiana	—	—	—	—	—	—	—	—	3.6/18	—	—	—	—	—
Quercus gambelii	—	—	—	—	—	—	—	—	2/4	—	—	—	—	—
Rosa woodsii	—	—	—	—	—	2.2/10	—	1.1/12	1.3/12	—	—	—	(1)/2	—
Rubus parviflorus	—	—	—	—	—	—	—	—	—	—	6.4/16	—	—	—
Sorbus scopulina	—	—	—	—	—	—	—	(1)/2	30/52	—	—	—	—	—
Symphoricarpos oreophilus	—	—	2.3/6	—	—	—	—	—	3.8/8	—	2.2/20	—	—	—
Graminoids														
Bromus anomalous	—	2.4/10	—	—	—	4/18	2.8/14	—	—	3.3/32	2.9/34	3/18	—	(1)/8
Bromus ciliatus	7.2/48	7.1/40	—	1.3/10	15/64	8/58	11/56	1.4/6	2.7/12	—	15/72	13/56	—	1.2/12
Calamagrostis canadensis	—	—	—	—	—	—	—	1.4/8	—	—	—	—	—	—
Calamagrostis rubescens	2.1/14	—	—	8.1/28	—	—	—	—	—	—	—	—	—	—
Carex geyeri	—	(1)/2	—	7.8/20	—	(1)/2	—	49/84	41/84	(1)/2	2.6/14	—	21/88	12/34
Carex laeviculmis	—	—	—	—	—	0.6/8	(1)/4	—	—	2.2/14	—	—	—	—
Carex raynoldsii	0.6/4	—	—	—	—	—	2.4/17	—	—	—	—	(1)/4	—	—
Elymus glaucus	17/88	11/56	27/92	36/96	—	—	2/10	25/66	11/46	10/58	17/84	21/78	20/60	25/80
Melica spectabilis	—	—	(1)/6	—	(1)/4	—	5.9/38	—	—	—	—	—	—	—
Phleum pratense	—	—	—	—	—	—	(1)/6	—	—	—	—	—	—	—
Poa canbyi	—	—	(1)/4	—	—	—	—	—	—	—	—	—	(1)/2	—
Poa interior	(1)/6	—	3.3/20	—	—	(1)/4	—	—	(1)/6	—	1.8/20	—	—	(1)/4
Poa leptocoma	—	—	1.2/10	(1)/4	—	(1)/6	—	3.4/40	—	1.4/16	(1)/6	0.6/10	—	—
Poa palustris	—	2.3/12	1.0/12	—	17/68	4/38	8.3/42	—	—	—	—	(1)/4	—	—
Poa pratensis	(1)/4	—	—	—	—	0.6/10	—	—	—	—	—	—	—	—

Forbs														
Achillea millefolium	—	—	—	—	—	6.6/68	9.2/32	—	(1)/4	(1)/2	—	(1)/2	—	(1)/4
Aconitum columbianum	—	2.4/10	—	—	0.8/4	—	—	2.2/6	(1)/2	1.6/10	—	—	—	(1)/2
Actaea rubra	—	—	—	—	—	—	—	—	—	—	—	—	(1)/2	—
Agastache urticifolia	—	—	(1)/4	—	—	—	3.4/18	—	—	0.6/4	3.8/32	1.4/14	(1)/2	(1)/2
Androsace septentrionalis puberulenta	—	—	—	—	—	—	(1)/4	—	—	—	—	(1)/2	—	—
Aquilegia caerulea	—	—	2.8/22	(1)/2	—	—	—	—	(1)/2	1.4/6	(1)/4	—	—	—
Arnica cordifolia	—	—	—	(1)/4	—	—	—	—	—	(1)/2	—	—	—	(1)/2
Aster engelmannii	(1)/4	(1)/4	—	6.1/34	—	6/36	—	8.2/36	20/62	5.7/24	2.5/12	4.8/18	12/52	6.7/36
Castilleja miniata	—	—	—	—	—	—	—	(1)/2	—	—	—	—	—	—
Chenopodium atrovirens	—	—	—	—	—	—	—	—	—	—	—	—	—	(1)/2
Cirsium sp.	—	—	—	—	—	—	(1)/2	1.3/12	3.9/20	—	—	—	0.7/6	—
Collomia linearis	—	—	—	—	—	1.4/16	—	—	—	—	—	—	—	—
Delphinium barbeyi	16/78	19/70	(1)/2	(1)/2	31/72	(1)/4	1.1/6	(1)/2	(1)/2	3.9/26	4.4/24	4.3/16	—	(1)/2
Delphinium nelsonii	—	—	—	—	—	—	(1)/4	—	—	—	—	—	—	—
Descurainia californica	—	2.2/18	—	—	—	—	—	—	—	—	—	(1)/6	—	(1)/2
Epilobium angustifolium	—	—	—	(1)/6	—	—	—	2.3/14	0.7/6	—	—	2.3/20	3.6/20	(1)/20
Equisetum arvense	—	—	—	—	—	—	1.9/10	—	—	—	—	—	—	—
Erigeron coulteri	(1)/2	—	(1)/2	—	—	—	—	—	—	—	1.8/12	—	(1)/2	—
Erigeron elatior	—	—	(1)/2	—	1.2/8	3.2/12	9.4/30	—	—	0.6/10	—	—	—	—
Erigeron speciosus	—	—	—	—	—	—	1.3/10	(1)/2	—	0.6/6	—	(1)/2	—	(1)/2
Fragaria sp.	—	—	3/20	1.2/8	(1)/6	8.3/64	—	0.8/12	(1)/2	0.4/6	—	(1)/2	1.5/12	0.9/26
Galium aparine	—	—	—	—	—	—	0.8/2	—	—	5.3/20	(1)/2	—	—	—
Galium boreale	—	—	(1)/2	(1)/4	4.3/26	3.7/30	5.9/36	3.6/34	(1)/8	2.1/24	(1)/2	1.2/10	(1)/10	1.6/14
Geranium richardsonii	7.8/68	0.7/6	27/88	16/78	5.9/40	14/66	4.1/24	9.7/38	15/52	12/64	(1)/2	8.8/36	3.9/14	18/70
Heliomeris multiflora	—	—	—	—	—	—	—	—	—	(1)/2	—	—	—	—
Heracleum sphondyllium	36/98	80/100	19/42	41/86	—	—	4.8/20	19/48	(1)/2	11/24	5.1/12	—	—	—
Hydrophyllum capitatum	8.3/58	—	—	—	23/66	(1)/2	3.3/32	—	—	—	(1)/4	—	—	—
Lathyrus leucanthus	—	—	(1)/2	4.1/20	—	—	4/30	1.1/6	8.6/38	1.4/6	—	3.2/26	0.7/6	—
Ligusticum porteri	(1)/4	—	16/46	19/62	7.7/14	29/68	2.1/14	7.6/16	21/48	2.3/6	2.4/8	2.3/6	0.7/2	14/32
Lupinus argenteus rubricaulis	—	—	(1)/2	—	—	1.8/14	—	(1)/2	1.5/12	—	—	—	7/42	2/10
Mertensia ciliata	3.5/30	5/26	—	—	2.2/12	1.3/2	4.4/24	—	—	0.7/8	—	1.1/4	—	1.4/6
Nemophila brevifolia	—	—	(1)/4	—	—	2.5/40	10/22	—	—	—	—	—	—	—
Osmorhiza sp.	—	(1)/6	—	6.8/30	—	5.2/30	7/40	—	11/54	7.7/38	3.6/20	7.5/48	16/56	0.6/4
Potentilla gracilis	—	—	—	—	—	(1)/6	(1)/2	—	—	—	—	—	—	(1)/2
Potentilla quinquefolia	—	—	(1)/2	—	—	—	—	—	—	—	(1)/4	—	—	—
Prunella vulgaris	—	—	—	—	—	—	(1)/6	—	—	—	(1)/2	—	—	—
Pseudocymopteris montanus	—	—	—	—	—	—	—	(1)/2	—	—	—	—	—	—
Pteridium aquilinum	—	—	—	1.1/4	0.8/2	—	—	64/90	48/80	48/90	58/90	71/98	62/88	74/100
Ranunculus alismaefolius	—	—	—	—	—	(1)/2	—	—	—	—	—	—	—	—
Ranunculus inamoenus	—	—	(1)/4	—	—	—	0.6/6	—	—	(1)/4	—	—	—	—
Ranunculus uncinatus parviflorus	(1)/2	—	(1)/2	—	—	2.2/20	1.4/8	—	—	—	—	—	—	—
Senecio serra	0.7/6	1.7/16	—	(1)/4	0.6/4	—	(1)/4	—	—	4.4/38	(1)/4	2/18	(1)/2	5.5/28
Silene menziesii	—	—	2.9/10	(1)/2	—	—	(1)/6	—	(1)/10	—	—	(1)/16	(1)/2	—
Smilacina racemosa	—	—	—	—	—	—	—	—	3.4/10	—	—	—	—	—
Stellaria jamesiana	—	(1)/2	—	—	0.7/8	(1)/2	—	(1)/2	(1)/2	0.9/16	6.2/50	(1)/12	(1)/18	(1)/2
Streptopus amplexifolius	—	—	—	—	—	—	—	—	(1)/2	—	—	—	—	—
Taraxacum sp.	0.7/6	—	(1)/2	(1)/2	—	11/44	0.6/6	0.5/8	—	(1)/2	—	—	—	—
Thalictrum fendleri	28/70	0.9/6	25/90	13/56	9.5/38	—	3.9/12	17/30	17/52	15/40	44/86	14/32	33/88	18/56
Thermopsis montana	—	—	(1)/6	—	—	1.1/22	—	—	—	—	(1)/2	—	—	1.4/6
Thlaspi montanum	—	—	—	—	—	—	1.1/22	—	—	—	—	(1)/2	—	—
Trillium ovatum	—	—	—	—	—	2.2/38	—	—	—	—	—	—	—	—
Valeriana occidentalis	2/20	0.8/10	0.9/6	—	1.9/16	1.7/8	0.8/2	—	—	—	—	3.2/20	—	2.7/20
Veratrum tenuipetalum	(1)/2	—	—	1.1/4	3/14	9.7/30	27/56	—	—	—	5.4/18	—	—	3.3/10
Vicia americana	—	—	(1)/2	3.8/24	—	2.3/20	—	27/88	2.5/22	3.2/20	(1)/2	1.4/8	9/30	1.6/14
Viola canadensis rugulosa	—	0.6/34	—	—	—	(1)/6	—	—	—	—	—	—	—	—
Viola nuttallii	7.1/44	—	1.4/14	—	—	—	1.7/28	—	(1)/12	1.1/12	1/28	(1)/2	—	—

[1]*Coverage of less than 0.5%.*

Table A-7.—Location, topographic position, coverage (percent), and frequency (percent) of undergrowth species in stands of the *Abies lasiocarpa/Vaccinium scoparium* habitat type

	Stand number																								
	41	43	56	85	86	87	93	1	2	28	3	47	48	50	51	57	58	63	64	60	96	97	30	45	73
Location:																									
Section	29	36	32	21	29	4	20	34	35	32	10	15	9	19	19	15	13	13	8	22	8	24	32	28	9
Township	5N	5N	5N	2S	3S	1S	3N	10N	10N	10N	10N	11N	11N	11N	11N	12N	12N	10N	9N	5N	5N	5N	5N	6N	7N
Range	80W	78W	80W	77W	77W	77W	78W	88W	88W	88W	86W	85W	85W	84W	84W	85W	85W	84W	84W	83W	83W	83W	82W	82W	82W
Topographic position:																									
Slope	25%	21%	10%	33%	24%	8%	25%	17%	21%	25%	30%	—	—	—	—	32%	—	10%	30%	—	5%	39%	—	15%	—
Aspect	241°	1°	51°	233°	56°	296°	6°	327°	23°	296°	121°	—	—	—	—	216°	—	276°	306°	—	226°	76°	—	5°	—
Elevation (m)	3,048	2,865	3,048	3,078	2,972	2,926	2,850	2,950	2,914	2,914	2,560	2,658	2,609	2,743	2,755	2,743	2,743	2,829	2,365	2,871	2,981	2,957	2,897	2,792	2,591
	Coverage/Frequency																								
Shrubs																									
Abies lasiocarpa	5.1/22	2.3/14	5.6/14	—	1.4/20	6.1/20	—	1/8	0.5/2	5.5/18	4.8/10	—	(')/4	2/18	4.1/56	2/12	1.8/12	—	1.2/14	18/40	(')/4	3.1/8	2.8/6	(')/4	(')/2
Amelanchier alnifolia	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	(')/2	—	—	—	—	—	—	—	—	(')/2
Ceanothus velutinus	—	—	—	—	—	—	—	—	—	(')/2	—	1.2/8	—	—	—	—	—	(')/2	—	—	—	—	—	—	—
Chimaphila umbellata	6.4/24	—	—	—	—	—	—	—	—	—	(')/10	—	—	—	—	—	—	—	—	—	—	—	—	—	(')/2
Juniperus communis	1/4	—	—	3.3/8	3.9/10	—	1.6/14	—	—	—	—	—	—	—	—	—	—	—	(')/4	—	—	—	—	—	1.7/20
Linnaea borealis	—	—	—	—	4.8/30	—	—	—	—	—	—	—	—	—	—	—	—	—	0.6/4	—	—	—	—	—	—
Lonicera involucrata	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	(')/2	3/14
Mahonia repens	—	—	—	(')/2	(')/4	—	—	—	—	—	—	—	—	—	—	0.8/10	—	—	—	—	—	—	—	—	—
Moneses uniflora	—	—	—	—	—	—	(')/2	—	—	(')/2	0.5/10	(')/4	—	—	—	—	—	—	(')/4	—	—	—	—	—	—
Pachistima myrsinites	2/20	2.9/36	1.6/22	0.5/8	1.6/22	—	—	0.8/18	3.8/26	1.1/22	5.6/58	—	1.1/6	—	(')/4	(')/8	(')/2	1.9/34	2.6/16	—	—	—	—	4.6/44	(')/2
Picea engelmannii	—	(')/2	—	(')/4	—	—	1/4	—	—	(')/2	0.6/4	—	—	—	—	—	—	—	—	—	(')/2	—	0.8/4	(')/2	—
Pinus contorta	—	(')/2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	(')/2	—	(')/2	—	—
Pyrola virens	—	—	0.5/14	—	—	—	1.4/22	—	(')/6	(')/4	0.6/20	—	—	—	(')/4	—	—	—	—	(')/2	—	—	—	—	—
Ramischia secunda	0.6/12	(')/2	5.1/58	—	—	(')/2	(')/2	2/20	4.2/36	1.5/38	(')/2	2/28	—	0.6/4	(')/2	—	(')/2	—	—	(')/4	—	—	(')/6	3.2/50	(')/4
Ribes montigenum	—	—	—	—	—	—	—	(')/2	—	—	—	—	—	—	—	—	—	(')/2	—	—	—	—	—	2.3/14	—
Rosa sp.	—	—	(')/4	—	1.4/16	—	—	—	—	—	—	0.8/12	(')/2	—	—	—	—	—	3.5/22	—	—	—	—	—	6.8/38
Rubus parviflorus	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2.1/18	—	—	—	—	—	—
Shepherdia canadensis	—	—	—	—	—	—	2.8/6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sorbus scopulina	—	—	—	—	—	—	—	—	0.6/4	(')/4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Vaccinium cespitosum	—	—	—	—	—	—	—	—	—	4.2/40	—	8.5/42	—	—	—	(')/2	—	—	—	—	—	—	—	—	—
Vaccinium myrtillus	1.1/14	1.1/12	3.1/24	6.8/32	16/52	23/78	21/78	—	—	—	—	(')/2	—	—	—	2.2/28	(')/6	3.1/16	40/94	—	5.6/34	2/22	8.6/42	6.7/20	18/58
Vaccinium scoparium	31/80	33/74	17/40	41/100	24/62	69/100	56/100	80/100	17/66	17/64	46/84	17/52	13/46	22/46	55/92	63/100	43/88	47/94	20/52	68/94	50/86	72/100	30/66	24/54	12/32
Graminoids																									
Bromus ciliatus	—	—	—	—	—	—	—	—	—	(')/2	—	(')/6	—	—	—	—	3/20	—	(')/4	—	(')/6	(')/2	—	(')/4	—
Calamagrostis rubescens	—	—	—	—	—	—	—	—	—	—	—	12/50	62/98	—	(')/4	—	—	—	23/88	—	—	—	—	—	—
Carex geyeri	16/32	(')/6	1.4/6	(')/2	3.2/14	—	—	—	9/22	(')/2	—	—	—	17/66	2.6/16	19/80	7.7/22	(')/2	(')/2	(')/4	0.8/12	4.5/16	—	4/14	—
Elymus glaucus	—	—	—	—	—	—	—	—	—	—	—	0.8/10	—	—	—	—	(')/2	—	—	(')/2	—	—	—	(')/2	1.3/10
Poa leptocoma	—	—	(')/6	—	—	—	—	—	0.7/18	—	—	—	—	—	—	—	—	(')/4	—	—	—	(')/2	—	(')/4	—
Poa nervosa	(')/4	—	—	0.6/14	—	—	(')/6	—	—	(')/4	—	—	—	(')/2	—	(')/2	—	—	—	—	(')/4	—	—	—	—
Trisetum spicatum	—	(')/2	—	—	0.7/14	—	—	—	—	—	(')/6	—	—	—	—	—	(')/2	—	—	(')/6	—	—	(')/2	—	—
Forbs																									
Achillea millefolium	—	—	—	—	—	—	—	—	—	—	—	—	(')/2	—	—	—	—	—	—	(')/2	(')/2	—	—	—	—
Anaphalis margaritacea	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2/10	—	0.5/10	—	—
Antennaria microphylla	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	(')/2	—	(')/4
Arnica cordifolia	0.8/12	(')/4	4.4/22	2.8/26	(')/4	(')/2	0.6/14	1.3/30	8.5/64	18/90	11/64	2.6/26	2/40	17/92	3.2/46	3.4/36	3.1/44	0.5/20	5.3/44	1.2/10	2.3/14	—	1.8/20	11/70	9/68
Arnica latifolia	(')/4	—	(')/6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4.1/28	—	—	—	—
Arnica parryi	—	—	—	—	—	—	—	—	—	(')/4	—	—	—	—	—	—	—	—	—	—	—	—	(')/2	—	—
Aster engelmannii	—	—	—	—	—	—	—	—	—	—	—	(')/2	—	—	(')/4	(')/4	(')/2	—	—	—	0.8/4	—	—	5.3/28	—
Aster follaceous	—	—	—	—	—	—	—	—	—	(')/4	—	—	—	—	—	—	—	—	—	—	—	(')/2	—	—	—
Campanula rotundifolia	—	(')/2	—	—	—	—	—	—	—	—	—	—	(')/2	—	—	—	—	—	—	—	—	—	—	—	—
Castilleja sulphurea	—	—	—	(')/4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Delphinium barbeyi	—	—	—	—	—	—	—	—	—	—	—	1.3/12	—	—	—	—	—	—	—	—	—	—	—	0.9/6	—
Epilobium angustifolium	—	—	—	—	—	0.8/12	(')/2	—	(')/10	—	(')/2	(')/8	(')/2	—	—	—	—	—	2.5/28	1.5/20	—	—	(')/4	(')/2	0.5/8
Erigeron peregrinus callianthemus	—	—	—	—	—	—	—	—	—	—	—	2/14	—	—	—	—	0.5/8	—	(')/6	2/20	—	—	—	—	—
Fragaria sp.	—	(')/2	—	—	—	—	—	—	—	—	—	1.3/30	(')/6	—	—	—	(')/12	—	(')/4	1.5/10	—	—	—	—	1.9/24

Galium aparine	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	(¹)/2	—
Galium boreale	—	—	—	—	—	—	—	—	—	—	—	2/32	—	—	—	—	—	—	(¹)/2	—	—	—	—	—	(¹)/4
Geranium richardsonii	—	—	—	—	—	—	—	—	—	(¹)/2.	—	3.9/36	—	—	—	—	0.5/10	—	—	—	—	—	—	6/30	—
Goodyera oblongifolia	—	—	—	—	—	—	—	—	—	—	(¹)/2	(¹)/2	—	—	—	—	—	—	—	—	—	—	—	—	(¹)/2
Haplopappus parryi	—	0.8/10	—	—	—	—	—	—	(¹)/4	—	—	(¹)/2	—	—	—	—	—	—	—	—	—	—	—	—	—
Heracleum sphondyllium	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	(¹)/6	—
Heuchera parviflora	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—		—	—	—	—	—	(¹)/2	—
Hieracium albiflorum	—	—	—	—	—	—	—	—	—	—	—	—	—	(¹)/4	1/20	0.6/4	—	—	—	(¹)/4	1.2/18	(¹)/2	(¹)/2	—	—
Lathyrus leucanthus	—	—	—	—	—	—	—	—	(¹)/4	(¹)/2	—	—	4.2/32	(¹)/4	—	—	—	—	7.7/28	—	—	—	—	1.4/8	4.5/24
Ligusticum porteri	—	—	—	—	—	—	—	—	—	—	—	0.8/10	—	—	—	—	—	—	—	2.2/12	0.6/4	—	—	2.7/10	—
Lupinus argenteus rubricaulis	1.4/6	3/14	—	—	—	1.3/4	—	—	—	(¹)/8	—	(¹)/4	5.8/48	—	(¹)/2	3.3/14	—	—	1.6/6	1.2/10	1.4/6	0.5/8	—	—	—
Mosses and lichens	3.2/14	8/50	6.2/28	5.7/38	20/80	2.1/8	7.6/36	5.8/54	1/10	5.5/36	7/32	8.8/34	0.8/14	(¹)/2	2.8/16	1.5/12	3.8/18	7/32	5/18	8.5/24	20/38	5.1/22	9.9/34	9.6/24	(¹)/6
Osmorhiza sp.	—	—	(¹)/2	—	—	—	—	(¹)/2	(¹)/4	0.5/10	2.1/18	(¹)/10	(¹)/2	(¹)/8	—	—	2.4/16	—	(¹)/4	(¹)/6	—	—	—	0.7/6	—
Pedicularis bracteosa paysonlana	—	—	—	—	—	—	—	(¹)/2	(¹)/2	—	—	—	—	—	—	—	—	—	—	—	—	—	(¹)/4	—	—
Pedicularis racemosa	—	—	—	—	(¹)/2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.8/2	—	—
Potentilla gracilis	—	—	—	—	—	—	—	—	—	—	—	—	—	(¹)/2	—	—	—	—	—	—	—	—	—	—	—
Pseudocymopteris montanus	—	—	—	—	—	—	—	—	—	—	—	—	—	(¹)/2	(¹)/2	—	1.9/26	—	—	—	—	—	—	—	0.7/6
Ranunculus uncinatus parviflorus	—	—	—	—	—	—	—	—	—	—	(¹)/2	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Senecio wootonii	—	—	—	—	—	(¹)/2	—	—	—	1.2/20	—	—	—	—	—	—	—	—	—	—	—	—	(¹)/2	—	—
Silene menziesii	—	—	—	—	—	—	—	—	—	—	—	—	—	(¹)/2	—	—	—	—	—	—	—	—	—	—	—
Smilacina racemosa	—	—	—	—	—	—	—	(¹)/2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	(¹)/4	—
Solidago multiradiata scopulorum	—	—	—	—	—	—	(¹)/2	—	(¹)/2	—	—	(¹)/6	—	—	0.9/6	—	—	—	—	—	—	—	—	0.6/4	6.2/60
Solidago spathulata neomexicana	—	(¹)/2	—	2.5/14	—	—	—	—	—	—	—	—	—	(¹)/8	—	—	—	—	(¹)/4	1.6/14	1.3/12	—	—	—	—
Streptopus amplexifolius	—	—	—	—	—	—	—	—	—	—	—	1.5/18	—	—	—	—	—	—	—	—	—	—	—	1.3/10	—
Thalictrum fendleri	—	—	—	—	—	—	—	—	1.1/6	—	—	0.8/10	—	—	—	—	—	—	—	—	—	—	—	(¹)/4	—
Thermopsis montana	—	—	—	—	—	—	—	—	1/8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Trillium ovatum	—	—	—	—	—	—	—	—	—	(¹)/2	—	(¹)/8	—	—	—	—	—	—	—	—	—	—	—	(¹)/2	0.5/12
Vicia americana	—	—	—	—	—	—	—	—	—	—	—	—	0.8/10	—	—	—	—	—	0.9/6	—	—	—	—	(¹)/2	—
Viola nuttallii	—	—	—	—	—	—	—	—	(¹)/2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.9/6	—
Zigadenus elegans	—	—	—	—	—	—	—	—	—	—	—	(¹)/2	—	—	—	—	—	—	—	—	—	—	—	—	(¹)/2

¹*Coverage of less than 0.5%.*

Table A-8.—Location, topographic position, coverage (percent) and frequency (percent) of undergrowth species in stands of the *Pinus contorta/Shepherdia canadensis* habitat type

	Stand number					
	40	44	82	83	31	33
Location:						
Section	20	25	21	29	20	19
Township	5N	5N	5N	5N	2N	2N
Range	80W	78W	78W	78W	82W	82W
Topographic position:						
Slope	5%	—	11%	25%	17%	21%
Aspect	251°	—	286°	131°	201°	159°
Elevation (m)	2,834	2,829	2,755	2,911	2,938	2,950
	Coverage/Frequency					
Shrubs						
Abies lasiocarpa	0.8/2	—	—	—	—	—
Arctostaphylos uva-ursi	—	(1)/2	—	—	—	—
Juniperus communis	2.7/12	8.8/18	10/20	9/26	2.4/8	4.9/12
Mahonia repens	—	—	1.8/14	0.5/10	0.5/10	1.3/14
Moneses uniflora	(1)/2	—	—	(1)/6	—	—
Pachistima myrsinites	6/46	—	1.1/6	10/58	0.9/14	1.4/16
Pinus contorta	—	1.9/6	—	—	—	—
Ramischia secunda	—	(1)/6	(1)/4	—	(1)/2	(1)/4
Rosa sp.	—	7.6/58	9/68	1.7/20	2.6/34	6.1/50
Shepherdia canadensis	31/70	11/18	5.7/10	3.6/18	25/52	34/54
Vaccinium cespitosum	0.7/8	9.7/66	—	—	—	—
Vaccinium myrtillus	—	0.7/8	5.8/62	17/70	25/86	15/62
Vaccinium scoparium	47/98	10/56	4.6/14	22/72	—	1.1/12
Graminoids						
Bromus ciliatus	—	—	—	—	—	(1)/2
Carex geyeri	—	4.8/18	1.2/2	—	9.8/25	1.6/6
Poa nervosa	(1)/4	—	—	—	0.6/8	—
Stipa lettermani	—	—	(1)/2	—	—	—
Trisetum spicatum	—	(1)/6	(1)/2	—	—	—
Forbs						
Anaphalis margaritacea	(1)/4	—	—	—	—	—
Arnica cordifolia	0.9/16	4.3/44	5.1/50	1.1/22	1.6/34	3.2/22
Campanula rotundifolia	—	—	(1)/2	—	—	—
Epilobium angustifolium	—	0.5/10	(1)/6	—	—	0.9/14
Erigeron speciosus	—	—	—	—	—	(1)/2
Fragaria sp.	—	0.5/8	0.5/20	—	—	(1)/2
Hieracium albiflorum	—	—	—	—	0.9/14	—
Lathyrus leucanthus	—	—	6/26	—	—	—
Lupinus argenteus rubricaulis	—	8.1/52	0.5/8	—	—	—
Mosses and lichens	3.8/16	0.7/8	1.6/8	3.1/18	1.8/22	3.4/18
Phlox sp.	—	—	—	—	—	(1)/2
Senecio wootonii	—	—	—	—	(1)/6	—
Solidago multiradiata	—	2.8/32	1.9/26	—	—	(1)/2
Solidago spathulata	—	—	—	—	—	(1)/4

Table A-9.—Location, topographic position, coverage (percent) and frequency (percent) of undergrowth species in stands of the *Abies lasiocarpa/Carex geyeri* habitat type

	Stand number										
	54	55	4	16	29	7	15	34	68	61	46
Location:											
Section	25	29	30	30	2	12	19	26	16	17	21
Township	5N	5N	3N	3N	9N	10N	11N	11N	11N	9N	7N
Range	81W	81W	86W	86W	88W	86W	84W	85W	85W	84W	82W
Topographic position:											
Slope	15%	11%	25%	15%	26%	20%	4%	5%	—	21%	—
Aspect	166°	178°	51°	331°	176°	116°	80°	339°	—	266°	—
Elevation (m)	2,926	2,952	2,667	2,682	2,804	2,652	2,792	2,621	2,557	2,411	2,633
	Coverage/Frequency										
Shrubs											
Abies lasiocarpa	16/30	12/22	—	2.2/12	13/22	—	—	10/34	—	—	—
Chimaphila umbellata	—	0.7/18	—	—	—	—	—	—	—	—	—
Juniperus communis	(')/2	(')/6	—	—	—	—	—	—	—	—	—
Mahonia repens	0.7/6	0.5/10	—	0.5/10	(')/2	(')/8	—	—	—	1.9/18	(')/2
Pachistima myrsinites	0.8/10	2/40	—	0.7/8	1.5/28	—	(')/2	—	(')/4	2.5/12	(')/4
Picea engelmannii	—	—	—	—	—	—	—	(')/4	—	—	—
Populus tremuloides	—	—	—	—	—	—	(')/6	—	—	—	—
Ramischia secunda	—	(')/2	—	—	(')/4	—	—	0.7/8	—	—	(')/2
Rosa sp.	0.8/10	0.9/14	2.3/6	1.6/22	1/10	—	—	—	4.4/32	1.9/16	8.2/40
Sambucus racemosa	—	—	—	(')/2	—	(')/2	—	—	—	—	—
Symphoricarpos oreophilus	—	—	1.1/6	4/18	—	(')/2	—	—	—	—	0.7/6
Vaccinium scoparium	11/32	4.4/6	—	—	8.8/24	—	—	(')/2	—	—	(')/2
Graminoids											
Agropyron elongatum	—	—	—	—	—	—	—	—	—	—	(')/2
Bromus anomalous	—	—	—	(')/4	—	—	—	—	—	—	—
Bromus ciliatus	—	—	12/60	—	—	(')/2	—	—	—	1.1/10	—
Calamagrostis rubescens	—	—	—	—	—	12/32	—	(')/2	26/88	50/100	—
Carex geyeri	45/86	32/76	5.4/16	10/36	24/82	32/62	20/84	10/38	36/86	12/70	15/64
Elymus glaucus	—	—	10/24	2.9/36	—	4.5/26	1.3/32	—	—	—	—
Melica spectabilis	—	—	—	—	—	—	—	—	—	(')/10	—
Poa nervosa	—	—	—	—	(')/2	—	(')/4	—	—	—	—
Poa pratensis	—	—	1.1/6	—	—	—	—	—	—	—	—
Trisetum spicatum	—	(')/4	—	—	—	—	—	—	—	—	—
Forbs											
Achillea millefolium	—	—	1.5/12	(')/2	—	—	(')/6	—	(')/2	—	(')/2
Agastache urticifolia	—	—	—	—	—	(')/2	—	—	—	—	—
Aquilegia caerulea	—	—	—	(')/6	—	—	—	—	—	—	—
Arabis drummondii	—	—	(')/2	—	(')/4	—	—	—	—	—	—
Arnica cordifolia	8.3/52	17/76	23/54	11/48	1/18	15/46	24/86	—	21/84	6.1/24	0.7/28
Aster engelmannii	—	—	—	—	0.5/10	—	—	—	—	—	(')/2
Campanula rotundifolia	—	—	—	—	—	—	—	(')/2	—	—	(')/2
Castilleja sulphurea	—	—	3.3/18	3.7/32	—	—	—	—	(')/2	3.4/28	—
Cirsium sp.	—	—	—	—	—	—	—	—	(')/2	—	—
Collomia linearis	—	—	—	—	—	—	—	—	(')/2	—	—
Delphinium barbeyi	—	—	—	—	—	—	—	—	—	(')/2	—
Descurainia californica	—	—	—	—	—	(')/2	—	—	—	—	—
Epilobium angustifolium	2.8/36	—	—	(')/2	(')/4	—	—	—	—	0.8/2	0.5/8
Erigeron elatior	—	—	3.9/10	—	(')/4	—	—	—	—	—	—
Erigeron speciosus	—	—	—	(')/2	—	—	(')/2	—	—	—	—
Erythronium grandiflorum	—	—	—	—	—	—	2.2/26	—	—	—	—
Fragaria sp.	—	—	4.7/42	2.4/36	—	(')/2	(')/14	(')/2	0.7/8	(')/4	2.8/24
Galium boreale	—	—	2.4/26	—	—	(')/2	—	—	(')/6	—	(')/4
Geranium richardsonii	—	—	—	0.6/12	—	—	(')/4	—	—	(')/6	1.2/16
Geranium viscosissimum	—	—	0.8/4	—	—	—	—	—	—	—	—
Helenium hoopesii	—	—	(')/4	—	—	—	—	—	—	—	—
Lathyrus leucanthus	14/56	3.2/14	4.7/18	17/46	1/14	4.6/18	2.6/16	—	31/92	—	17/68
Ligusticum porteri	—	—	—	—	0.9/6	2.3/14	—	—	1.1/4	5.1/22	—
Lupinus argentus rubricaulis	—	—	31/92	4.3/40	0.5/10	—	6.4/42	—	1.7/20	1/10	1/10
Mosses and lichens	1.1/6	1.8/14	—	—	2.5/10	—	—	15/44	—	—	0.8/2
Nemophila breviflora	—	—	—	—	—	—	(')/2	—	—	—	—
Osmorhiza sp.	(')/6	—	7.7/48	1.3/30	(')/6	2.7/20	1.1/24	0.5/10	0.5/10	(')/2	1.5/28
Pedicularis racemosa	—	—	1.7/8	—	—	—	—	—	—	—	—
Penstemon whippleanus	—	—	(')/2	—	—	—	—	—	—	—	—
Potentilla gracilis	—	—	—	(')/2	—	—	—	—	(')/2	—	(')/2
Pseudocymopteris montanus	—	—	—	—	—	—	(')/4	—	—	—	—
Senecio crassulus	—	—	—	2.8/24	—	—	—	—	—	(')/2	—
Senecio wootonii	—	—	1.4/6	—	1/10	—	—	—	—	—	—
Silene menziesii	—	—	—	—	(')/2	—	—	—	—	(')/2	—
Solidago multiradiata	—	—	—	—	—	—	—	1/12	(')/2	—	—
Solidago spathulata	1/10	0.5/8	—	—	—	—	—	—	—	—	(')/4
Streptopus amplexifolius	—	—	—	—	—	—	—	—	—	—	0.8/6
Taraxacum sp.	—	—	—	(')/6	—	—	—	—	(')/2	(')/4	(')/8
Thalictrum fendleri	—	—	2/4	2.1/10	1.4/8	1.4/10	—	—	2.3/6	—	—
Thermopsis montana	—	—	—	—	5.1/30	—	—	—	—	—	—
Trillium ovatum	—	—	—	—	—	—	—	—	(')/2	—	—
Veratrum tenuipetalum	—	—	—	—	1.1/4	—	—	—	—	(')/2	1/8
Vicia americana	—	—	1.8/6	1.5/10	0.9/10	8.7/22	—	—	—	24/68	3.6/34
Viola nuttallii	—	—	(')/2	—	—	(')/2	1.4/26	—	—	—	—

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Hoffman, George R., and Robert R. Alexander. 1980. Forest vegetation of the Routt National Forest in northwestern Colorado: A habitat type classification. USDA Forest Service Research Paper RM-221, 41 p. Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colo.

A vegetation classification based on concepts and methods developed by Daubenmire were used to identify 11 forest habitat types in the Routt National Forest. Included were five habitat types in the *Populus tremuloides* series, two in the *Abies lasiocarpa* series, and one each in *Pinus contorta*, *Pseudotsuga menziesii*, *Pinus flexilis*, and *Quercus gambelii* series. A key to identify the habitat types and the management implications associated with each are provided.

Keywords: Vegetation classification, habitat type, *Abies lasiocarpa*, *Picea engelmannii*, *Pinus contorta*, *Pinus flexilis*, *Pseudotsuga menziesii*, *Populus tremuloides*, *Quercus gambelii*

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